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THESIS

ENHANCED TACTICAL SYMBOLOGY FOR COMMAND AND CONTROL OF GROUND FORCES

by

Michael N. Hawrylak
Jeffrey W. Miller

March, 1985

Thesis Advisor: F.R. Richards

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A variety of design properties compiled from several sources that should be considered when fashioning a new military symbol group is discussed with

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The performance of this symbology is then evaluated through an experiment designed to compare the process of quickly and easily solving tactical problems with the enhanced decision aids versus the conventional. An analysis of the experiment results indicates that a commander can reach a tactical decision faster using enhanced symbology.

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Enhanced Tactical Symbology for Command and Control of Ground Forces

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I. INTRODUCTION

A. OVERVIEW

Because of the limitations of conventional symbology, ground combat unit commanders presently require a half dozen or so acetate map overlays and status boards for a comprehensive picture of the battlefield. But the modern battlefield allows little time for this manual, error-prone grease pencil plotting of symbols on numerous overlays. A method is needed to expeditiously collect and portray those essential elements of information a commander must have to make a sound decision. Time should not be wasted manually gathering and drawing or writing this information if a more efficient and reliable method can be found. The commander's time is best spent digesting the available information from a standardized, complete situation display.

The technology exists to automate this manual process. But before deciding how to display the needed information, it is better to first determine what information is required and how to represent it. In this thesis, we take a look at representing critical information. By employing state-of-the-art in microcomputer graphics, this information can be displayed to the commander in a useful and meaningful way and, hopefully, enable him to make more rapid and informed decisions than his enemy.

Our thesis is directed at, first, the design and, second, the evaluation of what we will refer to as "enhanced" ground-force map symbology. Enhanced symbology differs from conventional in that enhanced symbols quantify and clarify information on particular units such as combat effectiveness, personnel strength, equipment density and logistics readiness. We designed this symbology for support of tactical decision-making and for display using microcomputer graphics systems. The first two chapters of this thesis deal with the design process and arrive at a suggested symbol set.

Our goal, however, was not to create a complete symbol set ready for immediate implementation but rather to provide a solid foundation on which to build a new enhanced symbology. Many readers will no doubt find faults with our design and that's expected--much research remains to be done to assess the symbology's full effectiveness from a "human factors" perspective. But we have found no single source that, in our opinion, adequately addresses the problem of clutter and how to lessen its effects when offering a new symbol design. Thus we discuss a variety of design properties compiled from several sources that should be considered when fashioning a new military symbol group. We believe that the negative effects of clutter can be greatly reduced through proper presentation of symbol attributes. Hence the reason behind each component part of our enhanced symbols is to minimize clutter.

As we are concerned with whether or not enhanced symbology can help a commander, the last two chapters of this thesis discuss the performance of our symbology. We evaluated this symbology through an experiment designed to compare the process of quickly, easily and comfortably solving tactical problems with enhanced decision aids versus conventional. Based on our analysis, enhanced symbology can be of considerable value to a commander.

B. CURRENT SYMBOLOGY SHORTFALLS

Conventional military symbology has developed over the ages as a graphic aid to provide its user a compressed pictorial representation of an item of operational interest, such as a unit, installation or piece of equipment. The symbol designs were selected for their iconic representation of desired information based on the approach that symbols with implied associations could be quickly and easily recognized and learned. U.S. Army Field Manual 21-30 [Ref. 1] offers the following guidance for military conventional symbology.

> Military symbols lose their value if they become complicated or cluttered with unnecessary detail. The purpose and level of command, the training and background of personnel, and the tactical situation determine the amount of information required to adequately represent military units and installations.

Conventional symbology was developed for manual use and thus fails to specifically identify a standardized format for automated information processing to meet the present needs of battlefield commanders. Although it allows flexibility to the commander, it does not provide him all the tools to portray critical items of information regarding his forces and a viable means to keep this information current on graphical displays.

Conventional symbology communicates such information as unit designation, size, higher echelons of commands, branch or function performed and sometimes type of weapons, organic vehicles and whether a unit is a rear or forward element. For information of this type, current symbology adequately serves its intended purpose. However, this "Who, What, and Where" approach used with a battlefield situation fails to consider critical information requirements needed by commanders on future battlefields. With the increased geographical area of the battlefield caused by the rapid movement of mechanized infantry, armor, supersonic aircraft and airmobile capabilities, situation overlays drawn in grease pencil are nearing an end. As the battlefield enlarges to thousands of square miles with an increased number of highly mobile units, the need grows for better symbols and frequent updating of situation displays. It will become necessary to quickly and accurately process information and to design symbology capable of rapidly displaying the changing status of fighting units.

There exists today an ever increasing need to display a growing range of tactical information for the battlefield commander. Current symbology clearly depicts a unit's administrative makeup, but is relatively useless in tactical analysis and decision making. This symbology does not provide information relative to the unit's actual status and combat readiness as required on a highly mobile, rapidly changing battlefield.

The increased employment of new military symbology methods by units in the field to compensate for the lack of information portrayal currently available in conventional symbology, emphasizes the need for an enhanced symbology. Unless standardized, the development of enhanced symbology techniques will lead to communication difficulties among users. With the advances in computer work-stations capable of rapid manipulation of graphics and map information, the technology exists to manage information and provide a graphical representation of the commander's critical information requirements in a uniform, simple and understandable symbology.

C. THE NEED FOR ENHANCED SYMBOLOGY

The United States may find itself at war in any of a number of places and in a wide variety of situations. We must be prepared to fight opponents with highly mechanized forces and ultra modern weapons whose range and lethality surpass anything we have previously experienced. The modern battlefield will be immense, and the ground battles intense, quick and extremely mobile. The intensity and lethality of battle will make command and control of engaged forces extremely difficult.

The support required for the highly sophisticated equipment, high attrition rates, high consumption rates of ammunition, fuel and other supplies, coupled with personnel attrition rates, increased mobility, availability of forces and the combat readiness of our units will comprise the essential variables for making decisions on the modern battlefield. The massive amounts of information which are now required by and can be provided to the commander complicate decision-making. Commanders no longer have the luxury of days or hours in which to make decisions. Now they have only minutes, or seconds, and must make tactical decisions consistent with rapid change and succession of events. Information derived from military operations must be processed and used more effectively than ever before.

Computer graphics provides us with the technology to manage information and present displays that aid decision-making by allowing commanders to better visualize the battlefield. Conventional symbology is currently used to represent tactical situations in concert with these graphics displays. But, this symbol system no longer provides for the ever increasing volume and complexity of tactical data. Items such as enemy strength, composition and activity are not clearly identified and thus leave many questions unanswered. The displayed symbology must be redesigned to give the commander the information he needs to form his decisions and the tools to implement those decisions. The need exists to collect this information in real time and present it to the commander in an effective manner.[1]

D. INFORMATION TO REPRESENT

To increase the efficiency of the decision-making process for battlefield tactical and logistical operations, new enhanced symbology must have the capability to represent dynamic information. Vital operational information should be selected and displayed to the commander, enabling him to instantaneously evaluate the status of his command and that of his opponent.

Information presentation must be done quickly and accurately and each level of command must be provided with the information it requires. Symbology must be designed to minimize clutter and yet display all the information deemed critical by the commander.

Based on a review of the U.S. Army's Force Level Information Requirements Plan (FLIRP) [Ref. 2], the revised Tactical Combat Operations (TCO) System functional baseline [Ref. 3] and the Commander's Critical Information Requirements (CCIR) [Ref. 4], we deem the following elements critical to the commander for analyzing friendly and enemy forces. We believe these elements of information should be an inherent part of any new enhanced military symbology. Granted, these items will not satisfy the information needs of all commanders, but they do, nevertheless, offer a baseline.

---

[1] We discuss only the presentation, not the collection of information in this thesis.

FRIENDLY

1. Identification
2. Type
3. Location
4. Task Organization
5. Mission
6. Combat Effectiveness
7. Personnel Status (Strength)
8. Major Weapon Type
9. Major Weapon Range
10. Weapons Status
11. Equipment Status
12. Ammunition Status
13. POL Status
14. Contact
15. Movement
16. Communications Status
17. Emergency Resupply Request

ENEMY

1. Identification
2. Type
3. Location
4. Activity
5. Strength
6. Major Weapon Type
7. Major Weapon Range
8. Vehicles
9. Formations
10. Special Capability
11. Movement
12. Time
13. Threat

E. SUMMARY

Conventional military symbols provide only a minimum amount of information to a commander. To get the information he needs, the commander must ask his staff or his units, rely on his own memory or search message traffic. This process delays his decision. Can he afford the cost?

The battlefield commander must be given useful tools to wage war on the modern battlefield, tools to speed his decision-making process. The graphical represention of the dynamic information is a tool with which the commander can immediately assess his assets and those of his opponent so his decision need not be delayed. In the next chapter, we develop such a tool.

II. DESIGN OF A SYMBOL SET

A. DESIGN CRITERIA

Symbol design must not only meet the application needs of the user, but must also address those factors which increase user performance if it is to make full use of the technological capabilities of today's graphic portrayal systems. A user viewing a display containing numerous symbols must be able to rapidly and accurately extract crucial tactical information. The incorporation of design features which allow for detectability and discriminability of graphic features in a symbol set should increase user performance. The design of enhanced symbology must lend itself to the emphasis of command functions and must produce a tactical symbology which may be utilized by commanders to accomplish their mission. In the view of Sidorsky, Gellman and Moses [Ref. 5: p. 2-1], tactical symbology designs must provide:

> ...symbols used to portray the information acquired, manipulated and displayed by a Tactical Operations Center in supporting the online information needs of a Commander engaged in planning and / or conducting a combat operation.

To a large extent, the impact on tactical decision making will be based on how well the symbol design is perceived and how easily it can be interpreted. But perception and interpretation are adversely affected by clutter. Therefore clutter minimization must be a design goal.

Display clutter is one of the most common problems of a visual display. The cluttered appearance of battlefield information displays directly impacts on an operator's ability to extract critical information and affects his comprehension of tactical information [Ref. 5: p. 4-13]. There is no absolute solution that can reduce clutter. Some have suggested that symbol detail be reduced, others that only critical elements be displayed and yet others suggest only maneuver and critical support elements be portrayed. The increase in the number of units and the need to portray critical items of information require the use of more and more symbols. The best way to reduce clutter is to utilize a combination of means outlined in this thesis, color, simple geometric shapes, multidimensional codes, etc., to design the simplest possible symbol containing the maximum amount of information. Couple this with the technological advances to produce separate overlays on a visual display and one may have a viable step in reducing clutter content [Ref. 5: pp. 4-13 - 4-16]. However, it is probable that there are other methods to reduce clutter not discussed in this report, such as scaling a symbol up or down on demand, allowing its information is be legible or hidden as desired.

Consequently, there are numerous symbol design characteristics which must be considered in the development of an enhanced symbol set. An important prerequisite for the development of such a system is how the required information should be graphically portrayed. Guidance in making these decisions was drawn from previous work, primarily from tactical display surveys conducted by the U.S. Army Research Institute for the Behavioral and Social Sciences, Anacapa Sciences, Incorporated, Santa Barbara, California and GTE Sylvania, Mountain View, California. The results of these surveys showed that there are several basic methods for graphically portraying tactical concepts [Refs. 5-10].

We will briefly discuss these methods as they apply to the following four areas which should be considered when designing a symbol set for minimum clutter.

- Discrimination of Information
- Salience of Information
- Techniques to Aid Search
- Composite Symbol Design Features

1. Discrimination of Information

A useful symbol set will allow a user to quickly distinguish among the individual members of the set. This includes both the symbols themselves as well as the information contained within each symbol. Symbols should be designed to complement rather than inhibit this process of discrimination. This can be achieved via proper use of popular coding methods for symbol primitives, such as lines, shapes and character strings, and symbol attributes, such as color, brightness and flashing. Improper use of any of these methods will impair discrimination so it is important to understand their strengths and limitations.

a. Color

Color research has been conducted to determine the maximum acceptable amount of color hues that could be detected by operators without the aid of additional legends. The greatest amount of discrimination resulted between the colors blue, green, yellow and red. Based on the results of published research in this area, it was determined that from eight to twelve separate colors should compose the maximum allowable size of an absolutely identifiable set of color attributes. Influences such as viewing conditions, display conditions and individual variables as to color discrimination capability were considered in determining this size [Ref. 6: p. 59].

b. Brightness

Brightness research has established the number of brightness levels that can be easily determined by an operator. Factors to consider in the design of a symbology code where brightness is a component is whether absolute or comparative judgements are desired, the number of steps needed for the brightness dimension and the ambient or other background lighting conditions present in the operational area. Discrimination of brightness levels is directly related to the selection of brightness codes which is influenced by the surrounding background illumination. Based on these factors, a maximum of three values of brightness coding in an operational setting are recommended. Under ideal conditions, a maximum of five brightness levels can be determined, but this requires a limited amount of training [Ref. 6: p. 55].

c. Flashing

A flash rate involves the temporary blinking of a light source at a specified frequency. The frequency is dependent upon brightness, contrast, on/off ratio and signal intensity. Research in flash rate coding has mainly been concerned with its use in identifying an emergency situation. Under ideal conditions, an individual can discriminate five flash rates. However in an operational setting, only a maximum of two to four flash rates should be utilized to provide for absolute judgement and reduce the possibility of error. In addition, the range of flash rate coding is recommended between .5 and 30 cycles per second, the best being 2 to 3 cps. This range was established to insure that the coding would fall below the flicker fusion rate, the rate at which a light source is perceived as being steady [Ref. 7: p. 2-25].

A word of caution--avoid using rates between 9 and 18 cps because this is near the alpha rhythm of the brain and can trigger an epileptic seizure in a susceptible individual [Ref. 8: p. 89].

d. Alphanumerics

Research in alphanumeric codes indicates that when performance of a task is not memory dependent, displays using alphanumeric characters provide for a more accurate identification than displays using conventional symbology. It was further determined that lower case letters are more discriminating than upper case letters. This is probably because lower case letters show an increased variation in shape and thus lend themselves more to detection from one another [Refs. 5,7,9: p. 4-10, p. 2-25, p. 45]. Additionally, tables (where each entry is a character string) should be limited to seven plus or minus two entries with the most important one on top and separate items on separate lines. Letters should be left-justified and numbers right-justified [Ref. 8: pp. 95-96].

e. Shape

Shape in graphics terminology is a set of primitives that collectively describe the spatial form of a symbol. Shape coding represents one of the more flexible schemes available for use in symbology design. It can be easily used to change the appearance of displays in order to differentiate between symbols. The choice of a shape coded alphabet should be based on factors which affect symbol identification and understanding. The ability of an operator to identify a specific shape coded symbol is dependent on his ability to tell symbols apart. Thus, the shape of the symbol and the number of symbols which reside in the set will directly impact on an individual's ability to discriminate among symbols. No maximum size of a shape-code alphabet has been recommended. But a set of twenty or more highly-discriminable geometric symbols is easily established and can be increased by the use of modifying slashes and lines. In addition, the ease with which an individual can learn the coded meaning of a symbol will be influenced by his association with shapes of a familiar type. Therefore, simple geometricly shaped symbols, such as a circle, square, semicircle or triangle are more easily recognized [Ref. 6: pp. 11, 14].

Furthermore, the accuracy by which shapes can be identified by size increments is very limited. A maximum of five different size attributes of a single shape can be absolutely identified, but under operational conditions, no more than three different sizes should be used [Ref. 6: p. 40].

2. Salience of Information

Though closely related to discrimination, salience pertains to how visually apparent one item of information is compared with another. Two different items of information can be discriminably coded yet one item may be no more salient than the other. More important information should be more pronounced than less important information. Therefore the salience of a particular item of information must be directly related to that item's value relative to other items. Salience of information can be controlled through the clever use of attributes, such as line angle, line width and color.

a. Line Angle Attribute

Horizontal and vertical lines appear more prominent to the observer than curved or diagonal lines and tend to capture the observer's visual attention. This is especially true when combined together to form geometric shapes such as a box. For example, the box shape of conventional symbology depicted in Figure 2.1 lends itself to guiding the observer's visual attention when observed on a display. The box shape is acquired and recognized initially by the observer due to the pattern of horizontal and vertical lines and only then does the observer's attention shift to the functional information contained within the box. The use of horizontal and vertical lines should be carefully considered to prevent their salient features from overcoming the importance of other information which the symbol should provide [Ref. 5: pp. 4-7, 4-20].

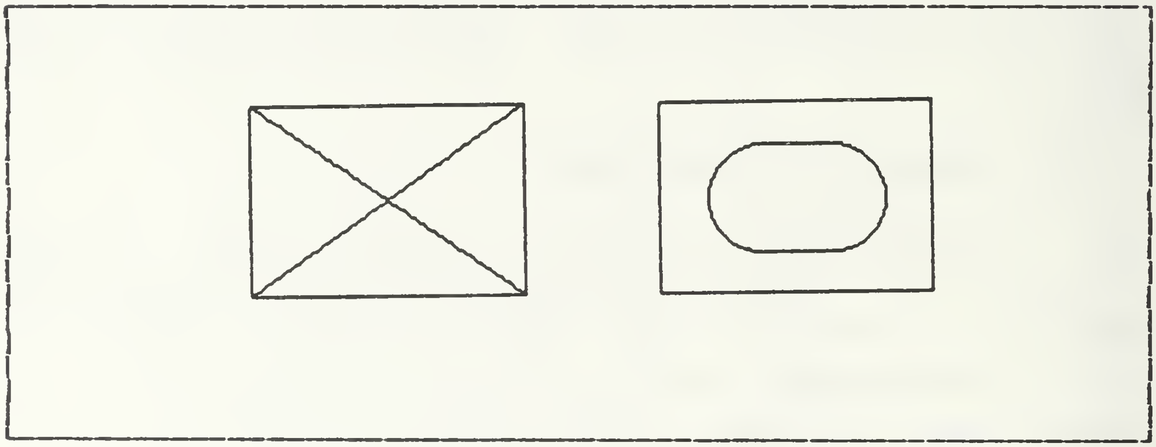


Figure 2.1 Similar Salient Design Features

b. Line Width Attribute

As mentioned above, the box feature of conventional symbology impairs identification of function due to its visually salient design format. Presently, the functions located within the interior of each symbol are represented with the same emphasis as the box which composes its perimeter, thus allowing the box format to be more perceptible.

Varying the line width of essential interior design features allows their design to overcome the salient design feature of the box perimeter. For example, compare the symbols of Figure 2.2. The armor symbol with wide lines will be more easily perceived than the one with thin lines. Therefore, this simple design modification will increase visual salience and discrimination and help to increase operator performance while reducing response time involving symbol identification tasks [Refs. 5,6: pp. 4-7, 4-8, p. 102].

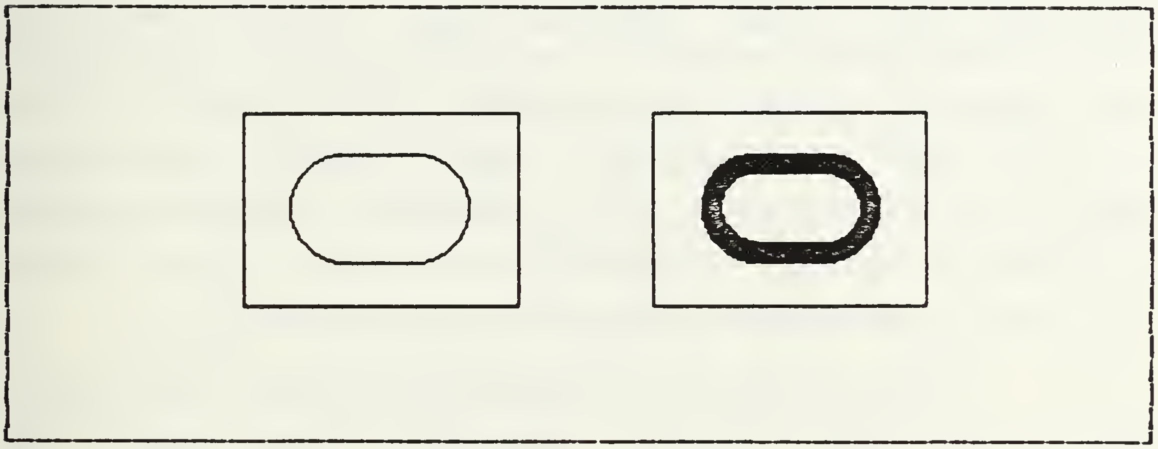


Figure 2.2 Saliency of Wide Lines

c. Color Attribute

Color provides the ability to strengthen the prominence of a symbcl and should be used to group elements and identify the most important or most often used tactical information. Colors which contrast most with the background should be used. If the background selected is going to change, color pairs such as white and red, bright yellow and black, bright yellow and blue or bright green and red are recommended. In addition, a color should be selected to reinforce its association (i.e. red for danger/enemy units).

The variation of color association such as green for safety, yellow for caution, red for danger or to indicate an emergency condition can help in providing additional tactical information when incorporated with a specific unit symbol [Refs. 5,9,10: p. 4-10, p. 47, p. 7].

3. Techniques to Aid Search

An important part of minimizing the apparent affects of clutter on a display is the construction of symbols that can be easily located and that signal warning conditions. The discriminative and salient coding methods described earlier effectively contribute to an individual's ability to find a desired piece of information. This search process can be further improved with combinations of dissimilar graphics primitives and with carefully selected color, brightness and flashing attributes.

a. Combinations of Primitives and Attributes

Combinations of graphics primitives and attributes have proven to be valuable for the design of symbology. Separate primitives or attributes used to code different elements of information are combined in the design of a single symbol. By increasing the number of primitives and attributes in a symbol design through different coding methods, one can increase the amount of information possible for display while permitting a user to visually select-out a needed piece of information. The use of dissimilar coding combinations has the capability to aid in search performance since separate primitives and attributes are used to code different information requirements of a single symbol. For example, a combination of color and shape could be formed to depict an information requirement and thus reduce the amount of search time to locate the desired piece of information.

b. Color, Brightness and Flashing

Color as a coding dimension no doubt aids search of a visual display. Knowing, for instance, that enemy units are displayed in red allows an operator to immediately locate those units. Research tends to agree that a color coding dimension can enhance performance, especially in search tasks, but must be carefully considered for the given situation and not just employed because it is available. The limited number of absolutely discriminable colors available, and the possibility of commanders or operators with partial or full color-blindness should be considered [Refs. 6,7: p. 87, p. 2-12].

Bright colors can assist the search process as well. For example, units in contact could be shown in a brighter color than units not in contact. The brighter symbols would then promptly capture an observer's attention.

Another way to direct an observer's attention is to flash the information elements that require action. Research found that flash rate coding reduces search time by up to fifty percent, especially with displays that contained a great deal of density. Flash coding has increased value when used to draw an operator's attention to new, changing or altered data on the visual display. However, the use of flash coding must be limited to these needs. Otherwise, the existence of flash codes with no important meaning would negate the use of flash coding altogether. Further, flashing codes should not be left on for long periods as they can become irritating to the observer. An operator should have the option of turning the flashing off once it is recognized [Ref. 6: p. 67].

4. Composite Symbol Design Features

Only with a thorough understanding of the methods for discrimination and salience of information and for aiding search, should one begin to compose a new symbol set. Since several elements of information are likely to be incorporated into a single symbol, the arrangement of the complete symbol must be well thought-out. Symbols should be multidimensional, associated with prior knowledge and not overly detailed. Additionally, symbol information content should be read in a left-right-clockwise manner and possibly presented in overlays. Finally, a symbol set can be created and stored as a font file.

a. Multidimensions

The use of multidimensional codes, such as size, color, shape and brightness, assists in the discrimination of symbols more than varying only a single dimension. In a battlefield display, the ability to recognize updated information becomes much easier when two variations are made in symbols representing altered information rather than just one. This is especially true when the amount of information presented is increased. A side effect of more information and multidimensions is confusion, so care must be taken to minimize or eliminate resemblance among design features.

The coding of important battlefield information should be accomplished to increase their salience and to improve identification performance. When a number of characters, symbols and geometric shapes are presented together on a visual display there exists a tendency for them to compete or even interfere with one another. The degree of interference among characters increases with their feature similarity. This interference has been shown to produce a tunnel vision effect on an operator. The box perimeter found on conventional military symbology is very effective in producing this effect. Thus for designing symbols that attempt to convey tactical information, features should be selected at different slopes and angles to minimize interference among symbol components. Conveying tactical information along more than a single dimension (i.e., function in one dimension - thick salient lines, and capability in another - color) greatly enhances the visual search process as well as user performance. Those items of tactical information which require visual search tasks to be conducted should be coded to take maximum advantage of salient design features [Ref. 5: p. 4-8].

b. Association Between Item and Concept

The selection of symbol design aspects should be based on an appropriate association between the displayed item and the concept it was meant to portray. Inherent associations should be identified and used where possible. For example, the association of the color red with danger should depict enemy forces not friendly forces. Taking advantage of inherent associations aids not only in operator response times and performance, but also allows the operator to classify groupings of symbols based on their similar associations. Research has also recommended the use of iconic symbols to simplify symbology identification, but iconic symbols make it difficult to represent certain crucial attributes such as combat power, readiness and task organization, etc. Thus, designers should take advantage of users' prior learning and conditioning to select symbol design features [Ref. 5,9,10: p. 4-25, p. 40, p. 10].

c. Detail

The detail of a symbol should be limited to the ability of the user to produce his own mental picture of that symbol. If the user can reproduce this mental image in his mind, he will be able to recall it more quickly and thus associate that symbol with the visual images presented to him on the display. A user's ability to recall this mental image of a symbol can greatly enhance his capability to find that symbol on a cluttered display. Complex, highly detailed symbols that cannot provide this mental snapshot can only slow down an operator's search process and increase the already complex visual display he will be asked to monitor [Ref. 5: p. 4-27].

d. Left-Right-Clockwise Scheme

To provide a standardized method for reading graphical symbols, a left-right-clockwise scheme should be used to extract pertinent data from symbols with visual information values. For unit identification read left to right across the identification character string which corresponds to an increase in echelons of command. For circular geometric symbols, i.e. pie charts, information should be read in a clockwise direction starting with the twelve o'clock position which will always correspond to zero. Vertical bar charts should be read from bottom to top with the value zero being at the bottom portion of the bar. Horizontal bar charts should be read from left to right with the left boundary indicating the zero value. Graduations used within a graphical symbol should be indicated and standardized throughout.

e. Overlays

Another possible method to reduce clutter is to provide the user with a selective call-up capability of several overlays. Hence the user can display only that information he desires to see. Perceptronics Corporation has done much research in the area of overlaying

[Ref. 11,12]. The corporation suggests up to twenty overlays involving friendly and enemy:

- maneuver units
- support units
- service support units
- unit designators
- major weapons
- percent strength
- weapon range
- movement

However, we do not evaluate an overlay technique in this thesis since our aim was to code the maximum amount of information in such a way that clutter effects are minimized even in a single overlay.

f. Font Concept

The development of each symbol set can be accomplished by defining each symbol as a character and building its respective font. Symbols of similar types can be placed together, creating a font file. The generated font files, stored in a computer's main or auxiliary memory, can then be easily recalled and displayed at the user's discretion. By means of the application software package, a separate file can be opened, the desired symbol characters recalled and the file saved to allow the retrieval and display of a composite tactical situation.

B. SYMBOL DESIGN

In the previous section, we outlined design criteria for an enhanced symbol set. Besides this criteria, we identified several other considerations to guide our efforts.

- Existing conventional symbology should be employed to the maximum extent possible. If current symbology can serve the purpose, use it.

- Enhancements should be incorporated directly into the symbology, rather than displayed in some designated portion of the screen, to ease comparisons between different units.
- The symbology should be as compact as possible, yet readable, to reduce clutter and to minimize computer memory.
- Color should not be the sole indicator of a particular information feature to allow the symbology to be used for monochromatic displays or by color-blind personnel.
- The symbology should include features that alert to problems.
- The symbols should be easy to draw.

With these criteria and considerations in mind, an enhanced symbol set was designed which incorporates all of the critical information requirements listed in Chapter I. By obeying the techniques for discrimination of information, salience of information and search aids, we believe our symbology effectively reduces apparent clutter while representing a substantial amount of information.

Specifically, our enhanced symbology uses six colors (blue, green, yellow, red, black and white), two brightness levels, one flash rate, five basic enemy shapes and eight basic friendly shapes (though admittedly not complete) and lower case letters. The functional descriptor of a unit is the most salient feature, unit status is next and all other information is the least salient. Color, brightness and flashing are employed as search aids and multidimensional, associative, minimum detail and left-right-clockwise coding are used in the composite design.

1. Friendly Units

The friendly unit symbology is shown in Figure 2.3. This symbol type is only applicable to combat and combat support units. Combat service support unit symbology is the subject of further research. The letters of the following headings correspond to the circled letters shown in Figure 2.3.

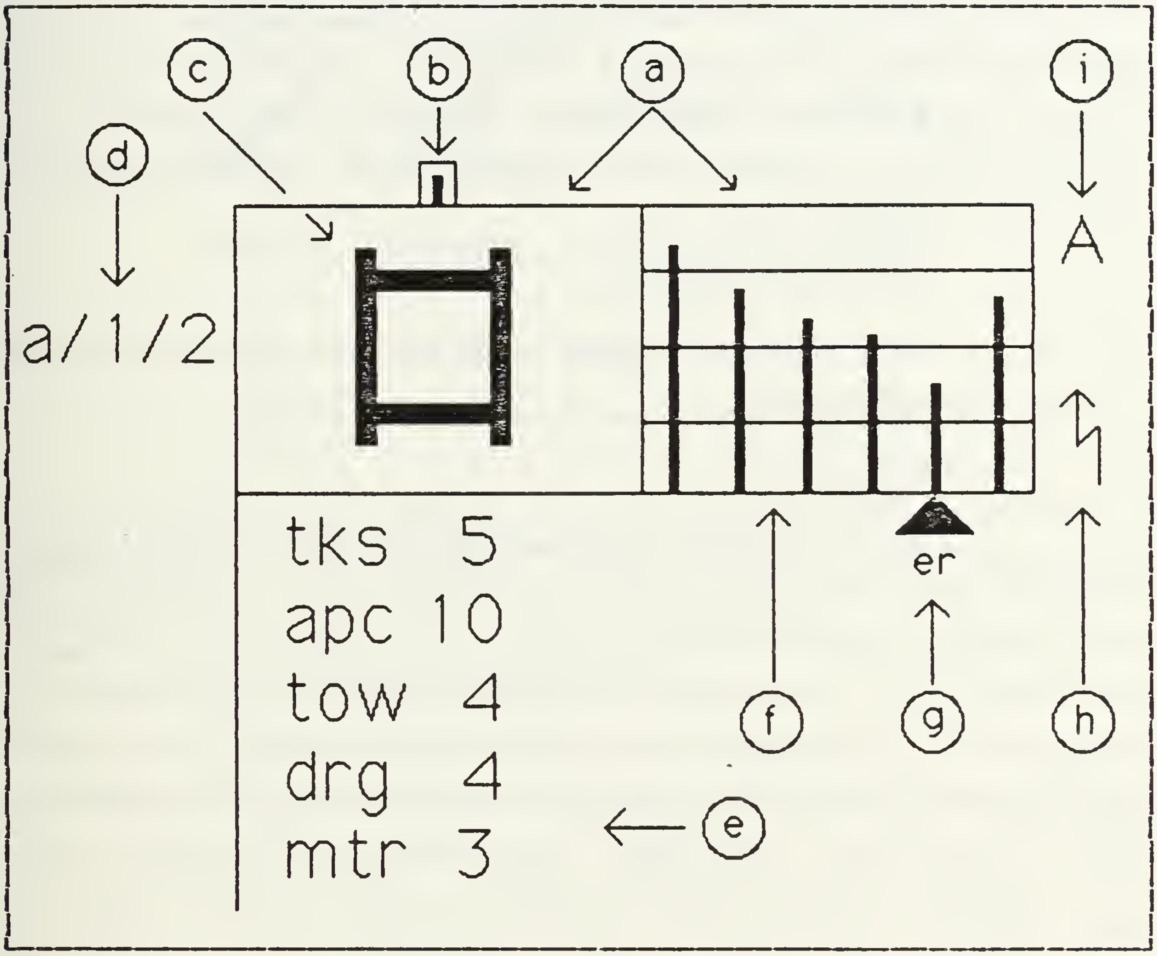


Figure 2.3 Friendly Unit Symbology

a. The Box and Unit Location

The box itself is an adaption of the "flag" used in conventional symbology. The box has been elongated with the right half graduated in four levels to enclose the bar chart described in 1f below. The stem from the lower left-hand corner of the box points to the unit's command post location on the map and the entire box is colored blue as is custom. Because horizontal and vertical lines are more salient than others, we evaluated boxless symbology. But the box serves as a convenient package within which to house information and was therefore retained. However, the lines of the box must be constructed as narrow as possible to minimize their saliency and prevent them from conflicting with other information.

b. Unit Size

Unit size is depicted as defined in FM 21-30 and is also colored blue.

c. Unit Type

Unit functional identification is displayed in the left half of the box and is colored blue. It must be the most salient portion of the symbol so units can be easily identified in a cluttered enhanced display. One method of doing so is to thicken the lines of standard functional descriptors. Though this method provides some improvement, a better way is to use simple geometric designs that imply their meaning and are discriminable. Figure 2.4 illustrates such designs.

Note that only the armor and mechanized infantry functional representations are substantially different from what is traditionally used. (However, these symbols, reversed, are currently used to represent individual tanks and personnel carriers, e.g. a diamond illustrates a personnel carrier). A diamond was chosen to represent armor as this shape is associated with a threat or danger [Ref. 5: p. E-6], and tanks usually provide the greatest threat on the battlefield. A box shape with the vertical lines

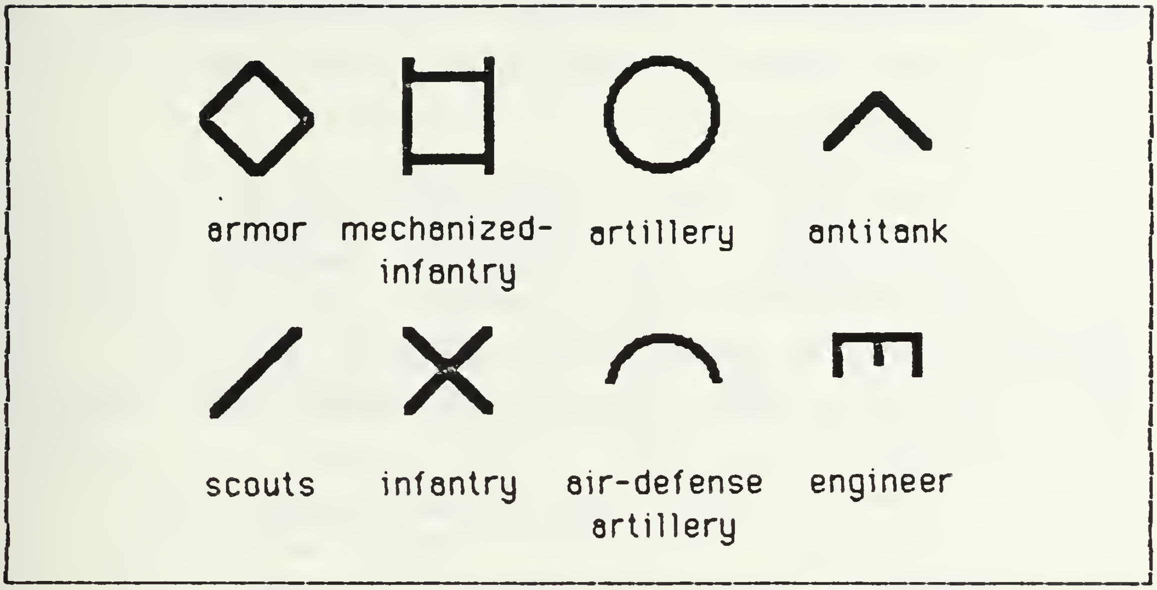


Figure 2.4 Functional Descriptors

extended beyond the corners was chosen to represent mechanized infantry because of its similarity to a mechanized vehicle.

d. Unit Identification

Unit identification is displayed to the left of the symbol in the customary company/battalion/brigade (regiment) format. Companies are designated with small letters because they are more salient than capital letters. If possible, this information should be displayed in yellow as yellow and blue provide a good color combination. However, yellow may be hard to read on many video systems as we discovered with ours (see Chapter IV).

e. Major Weapons (Task Organization Implied)

Major weapons and equipment are listed in small letters and numbers (for the same reason as above) and are displayed in the same color as unit identification. The numbers of weapons or equipment actually operational is shown, not the "Table of Organization" quantities.

f. Unit Status

The six bars in this chart signify the unit's status in six areas. A bar chart was selected because an Army Research Institute study preferred this technique when displaying relative quantities or measures [Ref. 13]. From left to right, the bars are personnel, ammunition, weapons, POL, equipment and combat effectiveness. To minimize clutter, these bars are not labeled so the user must memorize this order. The acronym "PAWPEC" can be used. The length of each bar, except combat effectiveness, represents the status as a ratio of the on-hand quantity to the "Table of Organization", "Table of Equipment", task organization or basic load authorization as is appropriate. Weapons status includes only those major weapons listed underneath the symbol (hence rifles and machineguns are not counted). Equipment status includes only the vehicles and equipment listed underneath the symbol as well. Note that equipment status, where applicable, will count the vehicle that transports a major weapon. Thus the main gun of a tank is a weapon while the tank vehicle is a piece of equipment. Combat effectiveness provides an overall picture of a unit's readiness in a weighted average of the other five status areas (which is the subject of further research). Six was chosen as the number of areas to graphically represent as the human mind can simultaneously comprehend seven plus or minus two items of information according to "Hriar Limit"[2] and there were six areas that lend themselves to this representation. Each bar is individually color coded according to the following scheme based on the perception that green is the "best" color, yellow is a warning and red is the "worst" color.

---

[2] Adams, R., Watership Down, (New York, Macmillan, 1972), p. 13.

STATUS	COLOR
76 - 100 Percent	Green
51 - 75 Percent	Yellow
0 - 50 Percent	Red

Thus a user observing a tactical situation display can immediately identify units with low status areas.

g. Emergency Resupply

Should any status area fall below some user selectable threshold value, say 50 percent, a red triangle is displayed which points to the status below threshold and flashes at a rate between .5 and 30 cps. A user should have the ability to turn the flashing off once it has captured his attention. This method was chosen because red is associated with danger, a triangle is extremely salient and has the ability to "point", and flashing aids searching. Thus it should immediately draw one's attention to any critical area. If the unit has submitted an emergency resupply request, a red "er" is displayed directly under the triangle.

h. Communications Status

Communications status, for the command net only, is portrayed by a lightning bolt shape with an arrow head. It is colored green with the arrow pointing up if secure communications are "up", red with the arrow up if only nonsecure communications are "up" or red with the arrow pointing down if the command net is "down".

i. Mission

Finally, the unit's mission is depicted with a capital letter (to differentiate it from a company designation) in the same color as unit identification. Maneuver unit missions include "A" for attack, "D" for defend, "R" for reserve, "W" for withdraw, and "-D" for delay. Support unit missions include "DS" for direct support, "GS" for general support, "GSR" for general support reinforcing and "OPC" for operational control. Additionally, the unit supported is shown with the mission such as "DS-a" indicating direct support to Company A.

2. Enemy Units

The same considerations and design criteria used for friendly symbology were used to symbolize enemy units. The symbol design was restricted to units found in the Soviet Armored and Motorized Rifle Divisions. We desired to design enemy symbology substantially different from friendly to better differentiate enemy and friendly units, especially in monochromatic displays (the conventional "double-box" style for enemy symbology is unsatisfactory). Figure 2.5 illustrates the basic geometric shapes used in the construction of enemy symbology.

The basic geometric shapes are appropriately combined to form meaningful enemy symbology. Figure 2.6 shows a typical Soviet Tank Regiment. The letters of the following headings correspond with the circled letters in Figure 2.6.

a. Unit Type, Location and Orientation

The geometric shape nearest the forward end of the symbol identifies the functional type of unit. Here, a tank unit with 95 tanks is shown. The center of this shape

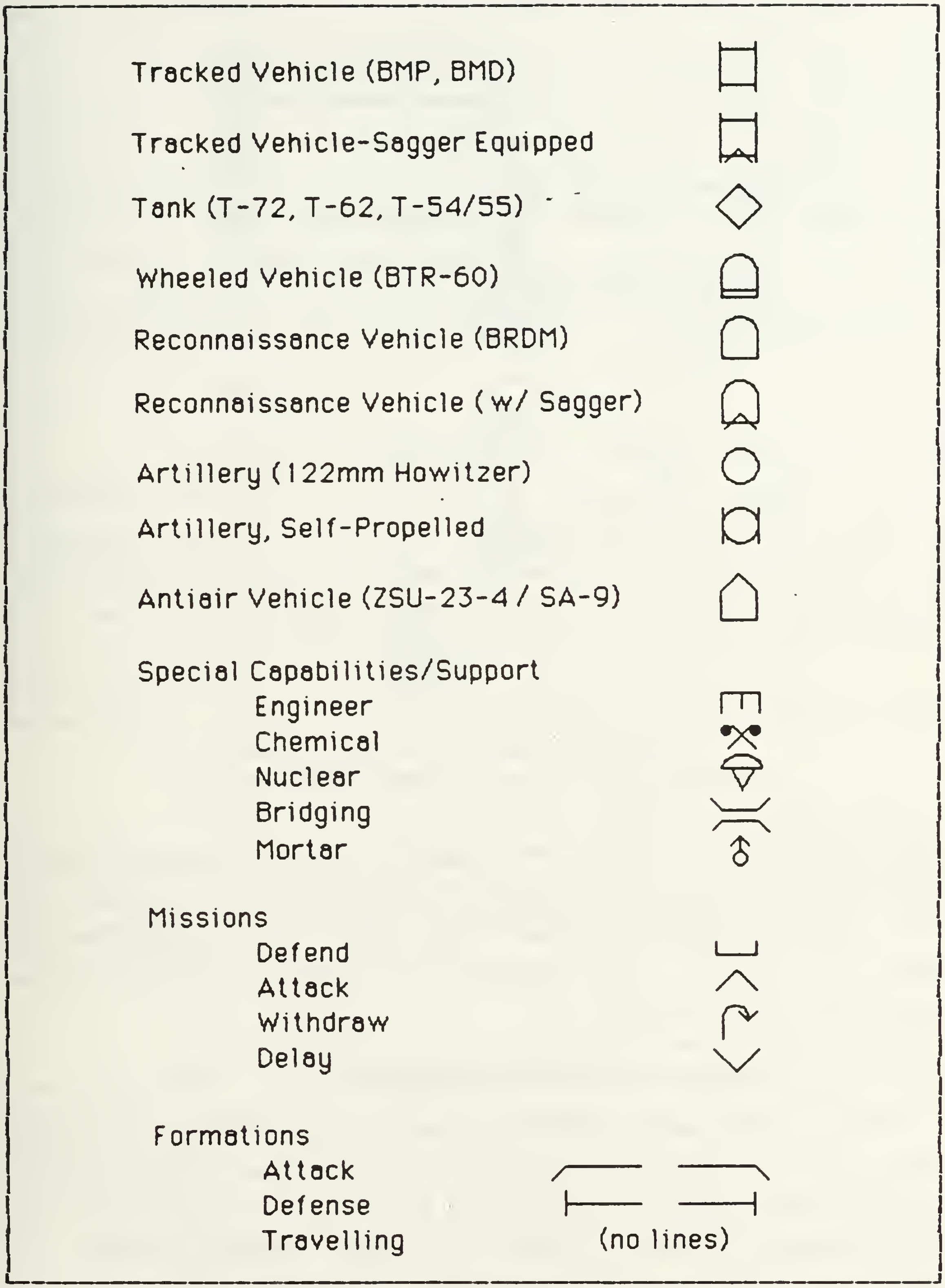

Tracked Vehicle (BMP, BMD)
Tracked Vehicle-Sagger Equipped
Tank (T-72, T-62, T-54/55)
Wheeled Vehicle (BTR-60)
Reconnaissance Vehicle (BRDM)
Reconnaissance Vehicle (w/ Sagger)
Artillery (122mm Howitzer)
Artillery, Self-Propelled
Antiair Vehicle (ZSU-23-4 / SA-9)
Special Capabilities/Support
Engineer
Chemical
Nuclear
Bridging
Mortar
Missions
Defend
Attack
Withdraw
Delay
Formations
Attack
Defense
Travelling
(no lines)

Figure 2.5 Basic Enemy Geometric Shapes

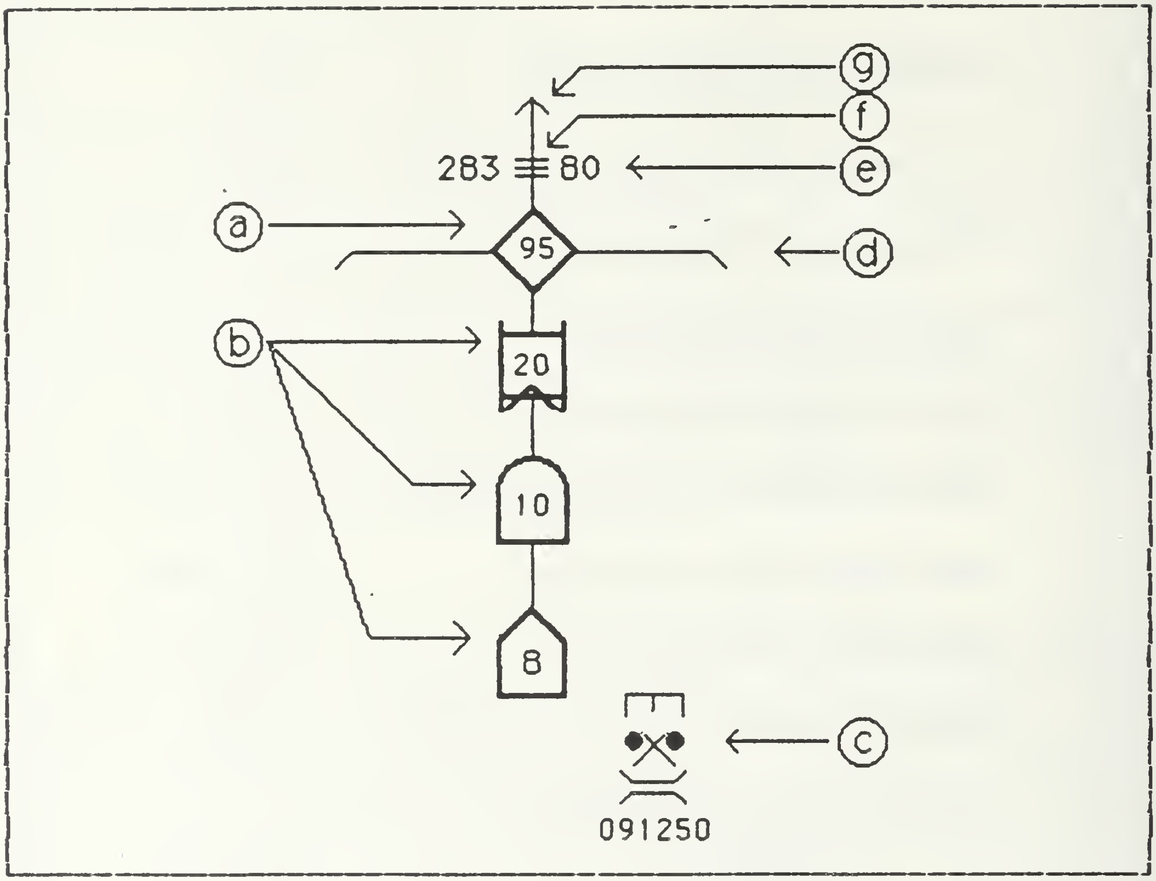


Figure 2.6 Soviet Tank Regiment

is positioned on the unit's location and the entire symbol is rotated around this point and placed in the direction of the unit's orientation on the map. Any alphanumerics displayed with an enemy symbol will remain upright despite the unit's orientation.

b. Major Weapons and Vehicles

Following the functional description, the major weapons and vehicles are drawn in column. The reported quantity of each weapon and vehicle type is written within the corresponding symbol. Here, 20 sagger equipped BMP's, 10 BRDM's and eight anti-air vehicles are shown.

c. Special Capabilities and Time

Special capabilities are presented in this area as well as the date/time group the unit was last reported. In this case, the tank unit has engineer, chemical and bridging capabilities and was last reported at 091250. To minimize clutter, this information should be displayed only with parent headquarters elements. Subordinate units then reflect only that information which differs from the capabilities and date/time group shown with their headquarters.

d. Formations

The unit's formation is depicted here using the formation lines of Figure 2.5. The actual length of the formation lines covers the estimated frontage the unit is operating on relative to the map. Where no formation lines are drawn, the unit is in a travelling formation or march column. Here, the tank unit is deployed in an attack formation.

e. Strength and Unit Identification

The estimated percentage strength of the unit is displayed on the right side and unit designation on the left (relative to the unit's orientation). In this case, the 283d Tank Regiment is estimated at 80 percent personnel.

f. Unit Size

The unit size is indicated here in a manner similar to the current practice where a single line represents a company, two lines a battalion, three lines a regiment, etc.

g. Activity (Mission)

The unit's mission is symbolized at the end of the line. In this case, the attack mission is indicated. Note the arrow-head shows only movement if the unit is in a travelling formation since mission probably cannot be inferred. If the unit is stationary and the mission is not known, then no arrow-head is displayed.

h. Threat

Threat is more subjective than objective and therefore is not specifically coded. However, with a combination of the design criteria previously specified, the concept of threat can be portrayed. Color, intensity, the display of enemy weapon systems and assets, flashing symbols and the formations of enemy units all lend themselves to the perception of threat.

i. Color Scheme and Examples

With the exception of numbers and special capabilities, enemy symbology is displayed in red. Numbers and capabilities are shown in white (or black if white does not significantly contrast from the background map) as white combines well with red and is easily distinguishable from similar friendly information in yellow.

Figure 2.7 shows examples of other units, formations and missions.

3. Friendly and Enemy Information Identically Displayed

a. Major Weapon Range

Weapon range is depicted at the user's option by displaying range arcs appropriate to a unit's major weapons centered on that unit's position and directed along the azimuth of interest. The arcs are colored blue for friendly units and red for enemy units.

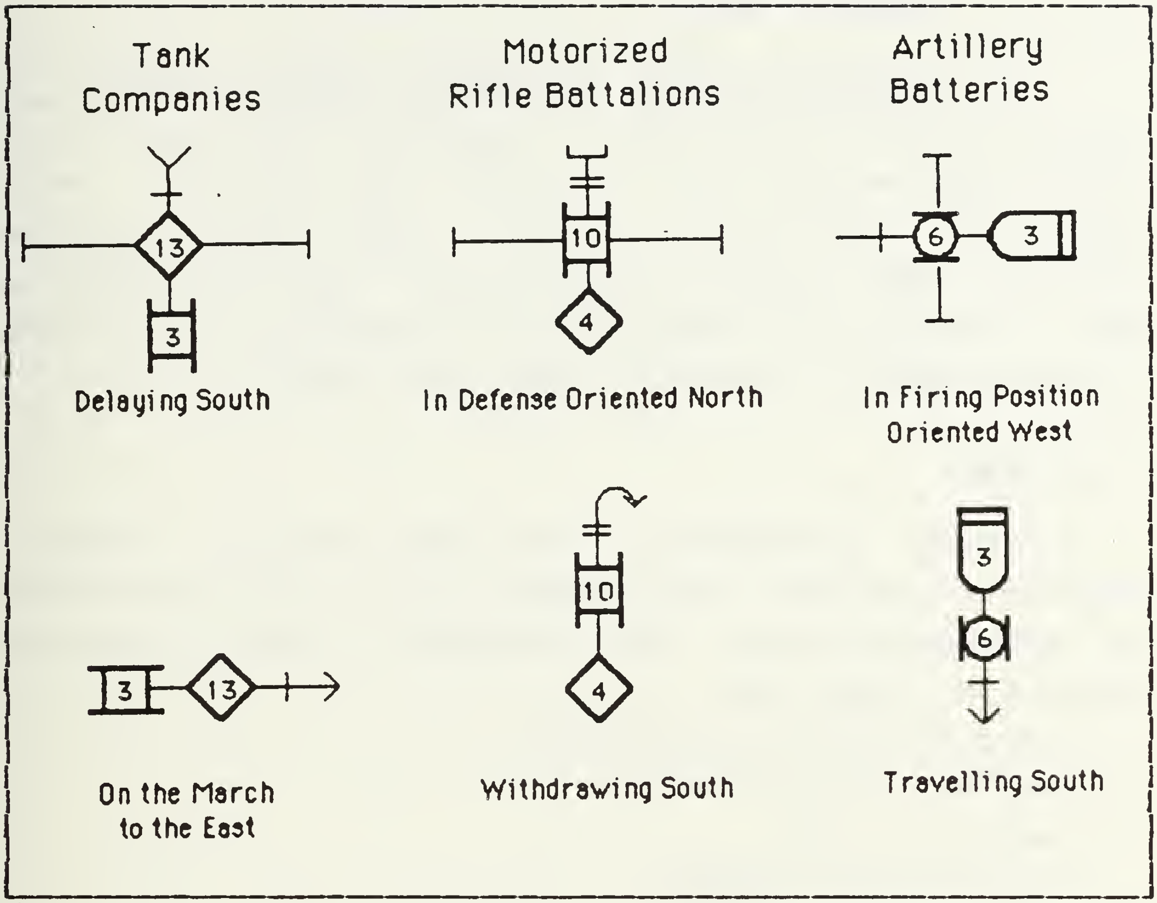


Figure 2.7 Units, Formations and Missions

b. Contact

Friendly and enemy units in contact is represented by intensifying the involved units' symbols. Brighter units are then those reported in contact with the enemy.

c. Movement

Movement history of both friendly and enemy elements is shown with narrow blue or red lines, as appropriate, connected between successive reported positions. Movement history should be displayed only at the user's option, to minimize clutter.

d. Unknown Status

Realizing that at times certain elements of information may not be known, especially with enemy units, unknown information items are simply not displayed. So no number will appear within an enemy symbol where it is not known how many vehicles of that symbol type are with that unit. Further, if an enemy unit is suspected at a location, a question-mark is displayed within the symbol.

C. SUMMARY

As stated in Chapter I, our goal was not to create a complete symbol set, but rather to lay a solid foundation for an enhanced set. The structure of this foundation consists of coding for:

- discrimination of information
- salience of information
- search aids and
- the composite symbol

through the use of:

- no more than 8-12 colors
- no more than 3 brightness steps
- no more than 2-4 flash rates
- lower case letters
- simple, minimum detail geometric shapes
- wide lines for more salience, narrow for less
- multidimensional symbols and
- codes associated with concepts.

On this foundation, we then built a partial symbol set for friendly and enemy combat and combat support units. This symbol set incorporates all of those critical items of information listed in Chapter I and presents them in a logical manner that suppresses clutter.

But can enhanced symbology be of any value to the commander? Is his performance likely to improve if he can use it? The answer lies in the following two chapters.

III. EXPERIMENT DESIGN AND PROCEDURE

In this chapter we describe an experiment that was conducted to assess the usefulness of enhanced symbology in a tactical situation. The experiment is based on our belief that the successful commander must reach a better informed decision in less time than his opponent. Two tactical situations were constructed in which U.S. Army and U.S. Marine Corps officers were required to answer a series of questions asking them to either make a decision or to extract information they would require to make a decision.

To compare the enhanced symbology against the conventional, we decided to measure the speed and accuracy with which these officers responded to the questions for each tactical situation using both conventional and enhanced symbology.

The purpose of enhanced symbology is to permit the commander to solve problems while viewing a tactical display. Since conventional symbology does not exhibit enough information to solve problems, the commander must look elsewhere--his staff, his units, his memory or message traffic. Thus in our experiment, we had to model this "conventional" procedure. We chose to furnish the subjects with status-report type message traffic organized by staff section and allow them to review the traffic prior to entering recorded portions of the experiment. In this way, we could simulate the commander turning to his staff, units, memory or message traffic for needed information.

The experiment involves an offensive and a defensive tactical situation. For each subject, one situation was presented using conventional symbology and the other using enhanced symbology.

Each situation was divided into three phases. Phases I and II asked a series of questions requiring the subject to extract from the situation display and/or hard copy messages, tactical information he would require to make a decision. Phase III asked questions that required the subject to make decisions regarding the tactical employment of his forces. By organizing the experiment in this manner, the subject would gain an understanding of the situation as it evolved over time just as he would in an actual situation. This then gave us a more realistic simulation of current tactical operations.

Phase I began prior to enemy contact and was designed to orient the subject to the present situation. The subject's performance was not recorded during this phase so that he could become familiar with the situation and the tasks necessary to answer the questions. The subject had to correctly answer each question before proceeding with the next.

Phase II began a few hours later in the situation after enemy contact had begun. The questions were similar to those of Phase I and the subject's performance was measured (time to correct response and accuracy of initial response). The subject had to correctly respond to each question as in Phase I. Phase II generated the data for Measures of Effectiveness 1 through 4 (see IIIB below).

Phase III began well into the situation. For each question, the subject was given several courses of action regarding the tactical employment of his units. The subject was asked to select the best course of action based on his understanding of the situation as it had developed. These questions had no correct answers so the subject was asked to defend his selections (to hopefully prevent him from merely choosing a course of action tc end the experiment). The subject's response times were recorded providing the data for Measure of Effectiveness 5 (see IIIB below).

A. OBJECTIVES

The experiment's objectives were twofold:

1. Objective 1

Evaluate the effectiveness of enhanced symbology in permitting the commander to quickly and accurately determine the present friendly and enemy situations.

2. Objective 2

Evaluate the effectiveness of enhanced symbology in speeding the commander's decision-making process.

B. MEASURES OF EFFECTIVENESS (MOE)

From the experiment objectives, five measures of effectiveness follow:

1. MOE 1

The cumulative time required to correctly respond to several questions requiring the subject to accurately extract friendly present situation information.

2. MOE 2

The cumulative time required to correctly respond to several questions requiring the subject to accurately extract enemy present situation information.

3. MOE 3

The total number of questions, from a series of questions requiring the subject to accurately extract friendly present situation information, correctly answered by the subject on his initial response.

4. MOE 4

The total number of questions, from a series of questions requiring the subject to accurately extract enemy present situation information, correctly answered by the subject on his initial response.

5. MOE 5

The cumulative time required to respond to a set of questions requiring the subject to reach tactical decisions.

C. HYPOTHESES

The null hypotheses below follow for each measure of effectiveness. (In all cases the alternative hypotheses state that the measures specified in the null hypotheses are not the same. The variables m(cx) and m(ex) denote the mean time (or score) using conventional or enhanced symbology, respectively, for the x-th MOE.)

1. For MOE 1

Ho: There is no difference in present situation correct response time between conventional and enhanced friendly symbology.

$$m(c1) = m(e1)$$

2. For MOE 2

Ho: There is no difference in present situation correct response time between conventional and enhanced enemy symbology.

$$m(c2) = m(e2)$$

3. For MOE 3

Ho: There is no difference in accuracy of initial response between conventional and enhanced friendly symbology.

$$m(c3) = m(e3)$$

4. For MOE 4

Ho: There is no difference in accuracy of initial response between conventional and enhanced enemy symbology.

$$m(c4) = m(e4)$$

5. For MOE 5

Ho: There is no difference in tactical decision response time between conventional and enhanced symbology.

$$m(c5) = m(e5)$$

D. INDEPENDENT VARIABLES

Various variables, which have potential for affecting the MOEs were included in our model (see IIIF below). These variables were:

1. Experience (e)

Two levels of experience were differentiated. Level one included those subjects with combat unit experience, such as infantry and armor officers, and level two included those subjects with combat support unit experience, such as artillery and air defense artillery officers.

2. Trial Number (x)

Each subject participated in two trials. Trial number was used to evaluate the effect of learning.

3. Presentation Mode (p)

The symbology was displayed in color and two presentation modes were identified—mode 1 for conventional symbology and mode 2 for enhanced symbology.

4. Tactical Situation (t)

The experiment involved two tactical situations. Tactical Situation 1 was an offensive operation and Tactical Situation 2 was a defensive operation.

E. FACTORS

The following factors, sometimes called "extraneous variables", were not selected for treatment as independent variables but nevertheless could affect the experiment results. These factors were held at a single level to minimize their effects.

1. Location

Only a single location was used as the experiment site (the Wargaming Analysis and Research Laboratory at the Naval Postgraduate School).

2. Complexity of the Tactical Situation

Though complexity is difficult to determine in an absolute sense, our intent was to develop two equally complex situations. Each situation matched the same battalion task force against an enemy force appropriate for the type of operation (offensive or defensive) and the tasks required for the subjects to perform were no more difficult in one situation than they were in the other.

3. Fatigue

The experiment was limited to 90 minutes per subject.

4. Display Apparatus

Each subject performed the experiment with the same equipment.

5. Display Brightness

The display brightness was held at the same level for each participant.

6. Room Light

The room light intensity of the experiment station was held constant for each subject.

7. Noise/Interference

The experiment station was isolated with partitions in the lab. Non-experiment personnel were asked to remain quiet and clear of the station.

8. Typing Ability

Only simple numerical inputs were required to answer questions.

F. MATHEMATICAL MODEL

The mathematical model considered for this experiment was:

$$Y(1-5) = m + e(i) + x(j) + p(k) + t(l) + pt(k,l) + n$$

where:

$Y(1)$ = cumulative time to correct response (MOE 1)

$Y(2)$ = cumulative time to correct response (MOE 2)

$Y(3)$ = number of correctly answered questions on initial response (MOE 3)

Y(4) = number of correctly answered questions on initial response (MOE 4)

Y(5) = cumulative response time (MOE 5)

m = mean time (or accuracy)

e(i) = total effect on time (or accuracy) due to experience level

x(j) = trial number

p(k) = total effect on time (or accuracy) due to presentation mode

t(l) = total effect on time (or accuracy) due to tactical situation

pt(k,l) = total effect on time (or accuracy) due to the interaction of presentation mode and tactical situation

n = noise (or error)

G. TACTICAL SITUATIONS

The two tactical situations developed for this experiment were derived from two situations used by the U.S. Army Infantry Officer Advanced Course [Refs. 14,15]. The enemy order of battle and tactics were drawn from "The Armies of the Warsaw Pact Nations" [Ref. 16]. Appendixes A and B contain the offensive and defensive operation orders, respectively. Appendix C shows the enemy order of battle.

Message traffic was written to support each tactical situation. The message formats were modified versions of those contained in 1st Brigade, 4th Mechanized Infantry Division Standing Operating Procedures [Ref. 17]. These messages provided the source information necessary to generate the situation displays and to answer questions whose solutions cannot be determined from the displays (especially when employing conventional symbology). Sample copies of these messages are included in Appendix D.

Figure 3.1 illustrates a conventional presentation mode display for the defensive tactical situation and Figure 3.2

shows the enhanced presentation mode display for the same situation.

Photographs of all the tactical situation displays are shown in Appendix E. For each situation, four displays were necessary--two for Phase I, one for Phase II and one for Phase III.

H. QUESTIONS

Experiment questions for Phase II were carefully chosen to encompass the four areas for analysis in the commander's decision-making process described by U.S. Army Field Manual 101-5 [Ref. 18] and were written similar to questions identified in ARI Technical Report 497 [Ref. 19]. These areas and the number of associated Phase II questions were:

Combat Service Support Situation - 2 questions
Personnel Situation - 2 questions
Relative Combat Power and Own Situation - 6 questions
Enemy Situation and Capabilities - 9 questions

Phase I questions (performance not measured) were chosen to orient the subject to the situation and acquaint him with the tasks required to answer Phase II questions (performance measured). Phase III questions dealt with mission accomplishment and required the subject to make decisions regarding the tactical employment of his forces.

Appendixes F and G list the questions by phase, with correct answers noted where applicable, for the offensive and defensive situations, respectively. Some of the questions vary slightly between the two situations because of the different types of operations involved. However the general structure and information need of these questions remain identical across the situations.

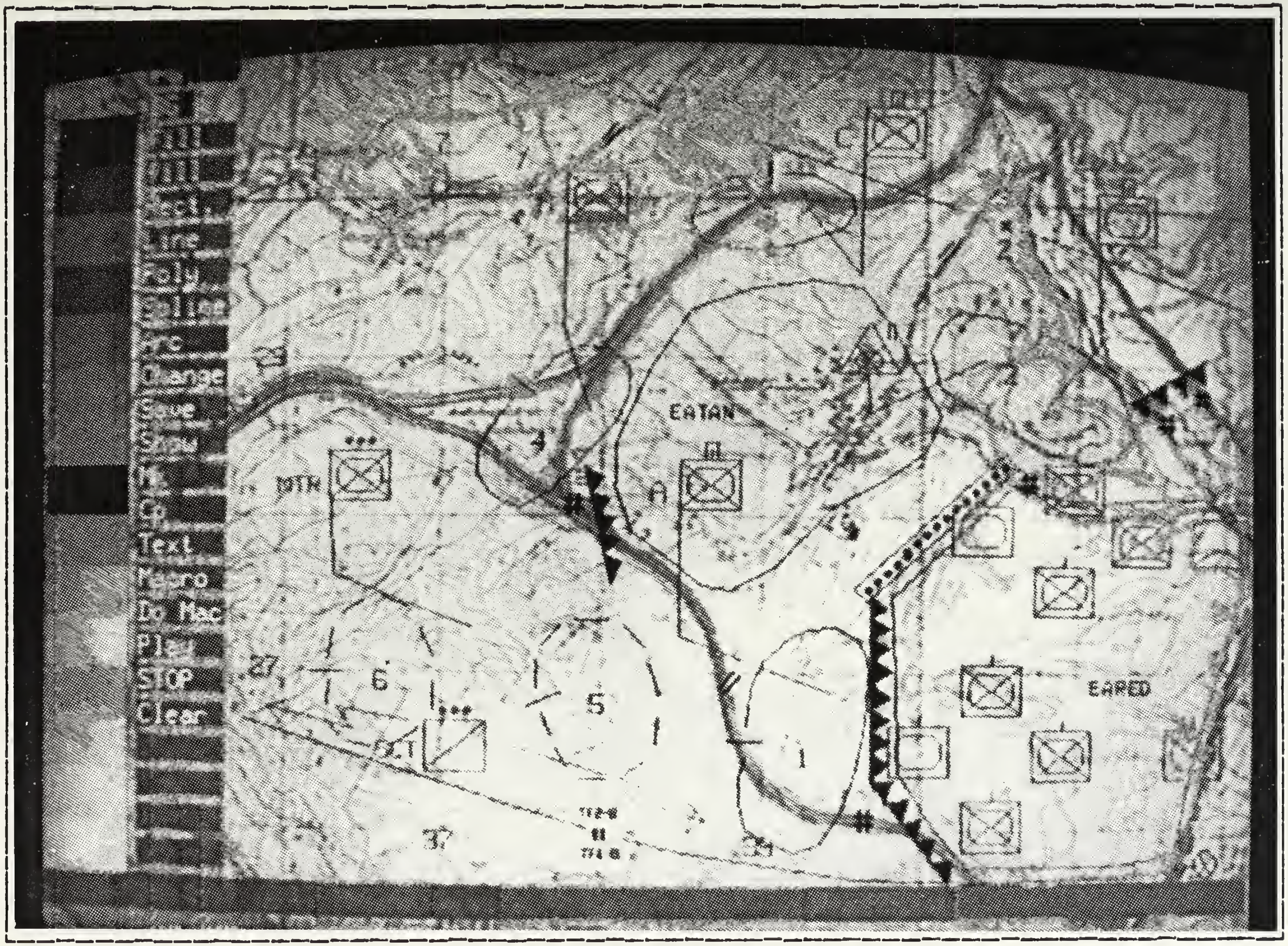


Figure 3.1 Phase II Conventional Defensive Display

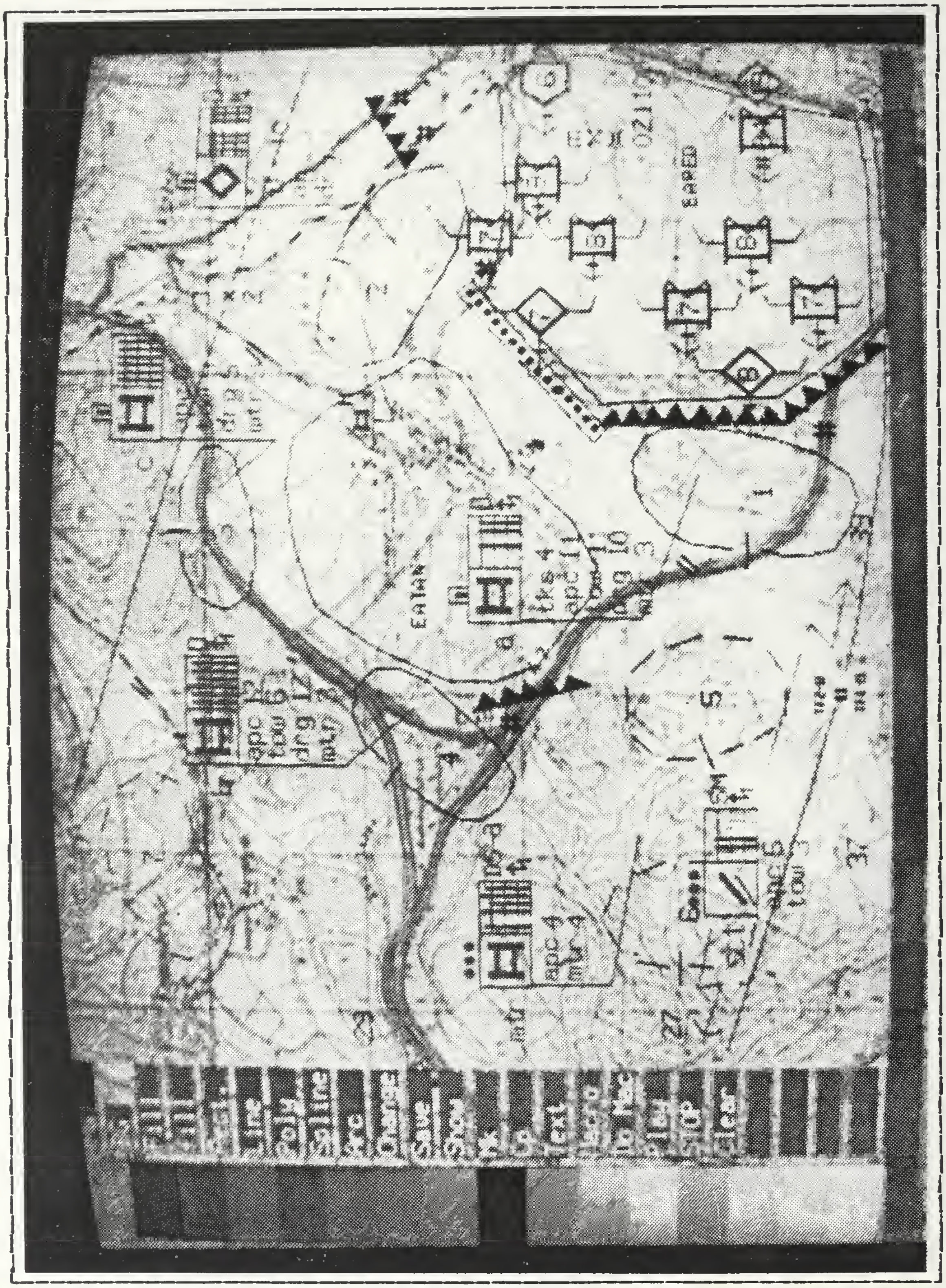


Figure 3.2 Phase II Enhanced Defensive Display

I. SCENARIO

The participants were individually tested according to the following scenario.

Each subject completed both tactical situations. One situation was presented in the conventional mode and the other in the enhanced mode. The order of the situations and modes was altered for each run of the experiment.

Each subject was briefed on the organization of the experiment and was required to accurately identify the components of the enhanced or conventional symbology before beginning the recorded trials.

When ready to begin a tactical situation, each subject was verbally issued the appropriate operation order. The subject then completed the three phases of the situation in order, first reading the message traffic (with no time limit so he could familiarize himself with the current situation) and then answering the questions associated with the particular phase. The time required to input the correct response and the number of attempts required to obtain the correct response were recorded for each Phase II question. The time to a response as well as the response made were recorded for each Phase III question. Additionally, for each Phase III question, the subject was asked to list the reasons why a particular course of action was selected. See Appendix H for a listing of the Fortran program that presented the questions and recorded the response times, attempts and responses.

Finally, once the subject finished both tactical situations, he was asked to complete a post exercise questionnaire (see Appendix I).

J. HARDWARE/SOFTWARE SET-UP

The experiment used the following equipment and Figure 3.3 illustrates the graphics hardware configuration.

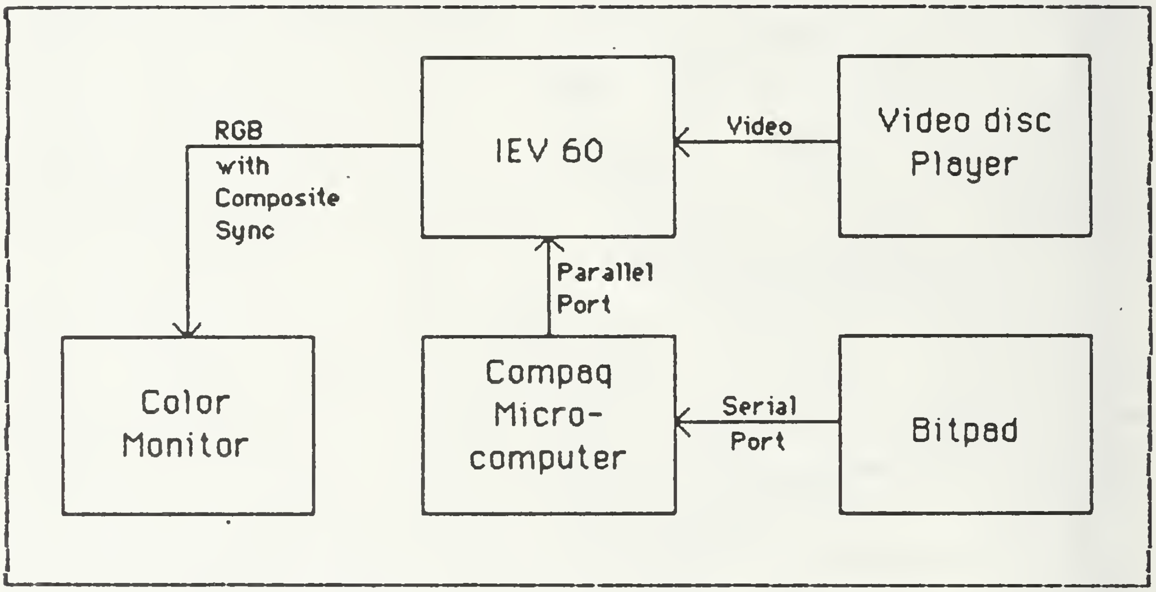


Figure 3.3 Graphics Hardware Configuration

- Sony PVM 1910 Color Monitor - displayed the tactical situations.
- Pioneer PR 7820 Video Disc Player - played the video disc maps used in the tactical situations.
- Perceptronics Inc. Video Disc of V Corps Germany - provided the video disc maps used in the experiment.
- IEV Corporation Model 60 Graphics Overlay System, IEV Corporation Bitpad and IEV Graphics Software - used to construct the conventional and enhanced symbology and tactical situations, overlay these situations on the video disc signal and present the combined video picture to the monitor.
- Compaq Microcomputer - received commands from the bitpad, ran the graphics software and sent commands to the IEV Model 60 to bring up the appropriate display.

- VAX 11/780 Minicomputer and Digital VT102 Terminal - executed the Fortran program (Appendix H) that generated the questions and collected the data for the experiment. The subjects read the questions and input their responses using the VT102 terminal.

K. PARTICIPANTS

Experiment subjects consisted of 25 volunteers with ground combat MOS's from U.S. Army and U.S. Marine Corps officer students at the Naval Postgraduate School. From the 25 volunteers, three participated in pilot trial runs prior to the record trials in order to calibrate the experiment. The remaining twenty-two served as subjects for the actual experiment.

Below is a profile of the record trial subjects.

	USA	USMC
Rank		
Capt	13	5
Maj	1	2
LtCol	0	1
MOS		
Infantry	4	3
Armor	4	0
Artillery	5	5
Air Defense	1	0

L. SUMMARY

We constructed the experiment described in this chapter to determine if enhanced symbology can speed a commander's decision-making process thereby giving him the opportunity to solve problems and react faster than his adversary. We structured the experiment to closely simulate the current "conventional" environment and compare it with a proposed "enhanced" environment. In the next chapter we evaluate these two environments by contrasting the time and accuracy with which the subjects solved tactical questions, and the time with which the subjects made tactical decisions, using conventional symbology versus using enhanced.

IV. EXPERIMENT RESULTS AND CONCLUSIONS

A. GENERAL COMMENTS

As previously stated in Chapter I, the major objective of this thesis was first to design and second to evaluate enhanced ground force map symbology. To conduct this evaluation, it was necessary to utilize selected tactical scenerios to act as a driver for our experiment and to provide the proper setting for the presentation of the symbology. To evaluate as many symbol design features as possible, the assumption was made that intelligence collection concerning enemy units would be optimal, allowing the means to portray enemy symbology in its largest capacity. It was our intent to evaluate the symbology design features by displaying the maximum amount of information and not to evaluate an individual's tactical ability or the means by which intelligence information was collected.

Due to hardware capability and quality limitations, minor alterations were made to the enhanced symbology. Friendly unit identification, the listing of major weapons and equipment and unit mission were presented in blue in lieu of yellow because yellow characters were not readable with the map background. In addition, black was utilized instead of white to indicate the quantity of enemy items for the same reason. Flashing of the red triangle, displayed to identify status areas below 50 percent, was prevented due to hardware limitations. Finally, the use of brightness steps to indicate friendly/enemy contact, the designation of enemy estimated personnel strength and enemy unit identification were not incorporated since questions concerning these elements were not asked.

B. DATA COLLECTION

Recall from Chapter III that for the second phase of each experiment trial, the subject was asked a series of questions requiring him to extract, from the situation display and/or hard copy messages, tactical information he would need to make a decision. Next, in the third phase, the subject was asked questions that required him to make decisions regarding the tactical employment of his forces, given several courses of action. For each related question, the subjects' Phase II times to correct response, Phase II number of attempts to correct response and Phase III times to response were collected by a computer program (Appendix H) and written into data files. The program further calculated the Phase II cumulative time to correct response (MOEs 1 and 2), the Phase II total number of questions correctly answered on initial response (MOEs 3 and 4) and the Phase III cumulative response time (MOE 5) by subject. This data was then consolidated into a more readable format and presented in Table I along with the level for each independent variable (see IIID and IIIF for a discussion of the variables, levels and column heading definitions).

C. ANALYSIS

A total of twenty-two subjects participated in the experiment yielding 43 observations (the VAX 11/780 "crashed" during the second trial of subject 18, losing the associated data) for each Measure of Effectiveness. An Analysis of Variance (ANOVA) was performed on each MOE using the mathematical model described in Chapter III, the collected data and an ANOVA computer program [Ref. 20].

Tables II-VI contain the ANOVA tables for MOEs 1 through 5, respectively. The first column of each table lists the sources of variation, as defined by the mathematical model,

TABLE I

RAW DATA

Subject	Y1	Y2	Y3	Y4	Y5	e	x	p	t
1	118.96	233.67	10	7	215.67	2	1	2	1
1	205.80	214.49	10	8	329.90	2	2	1	2
2	130.86	226.52	9	6	148.74	1	1	2	2
2	185.58	316.59	9	6	192.67	1	2	1	1
3	189.65	332.54	10	6	179.80	1	1	1	1
3	148.59	162.57	9	7	109.69	1	2	2	2
4	244.98	447.30	8	4	168.35	2	1	1	2
4	125.05	225.18	10	9	198.71	2	2	2	1
5	161.36	252.20	10	7	196.03	2	1	2	1
5	406.48	391.57	8	7	171.54	2	2	1	2
6	98.79	202.86	10	6	100.63	2	1	2	2
6	166.67	223.39	10	7	130.47	2	2	1	1
7	174.00	275.29	10	7	179.37	2	1	1	1
7	144.91	176.81	8	9	168.87	2	2	2	2
8	210.99	215.71	9	9	149.61	1	1	1	2
8	112.15	207.56	10	6	158.74	1	2	2	1
9	201.18	485.95	9	6	213.21	2	1	2	1
9	419.69	332.92	8	7	222.23	2	2	1	2
10	132.25	233.40	10	5	171.00	1	1	2	2
10	150.04	298.40	10	6	255.80	1	2	1	1
11	264.74	402.28	10	5	211.60	2	1	1	1
11	196.02	204.51	8	8	306.12	2	2	2	2
12	185.09	275.89	9	7	222.22	1	1	1	2
12	113.34	170.52	10	8	139.24	1	2	2	1
13	130.20	222.98	10	5	97.22	1	1	2	1
13	231.12	278.00	8	5	107.96	1	2	1	2
14	122.61	149.46	9	7	83.24	2	1	2	2
14	283.89	261.10	10	7	113.38	2	2	1	1
15	253.11	408.94	9	6	366.22	1	1	1	1
15	144.09	282.23	9	6	185.47	1	2	2	2
16	229.57	280.95	7	5	284.94	2	1	1	2
16	119.55	207.54	9	5	88.58	2	2	2	1
17	136.36	175.70	10	7	96.49	1	1	2	1
17	176.43	184.49	8	7	138.65	1	2	1	2
18	163.59	184.01	7	7	113.76	2	1	2	2
19	333.89	384.58	7	6	104.36	1	1	1	1
19	115.43	180.73	8	8	68.58	1	2	2	2
20	177.98	215.79	10	7	390.03	1	1	1	2
20	111.13	190.41	10	7	284.98	1	2	2	1
21	191.12	275.43	10	6	126.17	1	1	2	1
21	289.06	303.98	5	6	175.13	1	2	1	2
22	125.20	223.14	9	7	226.88	2	1	2	2
22	278.48	310.14	8	5	177.22	2	2	1	1

for the data set. The sources of particular importance are the four independent variables--experience, trial number, presentation mode and tactical situation. The next three columns list the degrees of freedom, sum of squares and mean square associated with each source. The resultant F-value is then shown for the model as well as each variable in the model, followed by the alpha level at which the model or variable becomes statistically significant. The four independent variables are again listed under the ANOVA table showing the number of observations (count), mean time (or score) and standard deviation for each level of each variable.

As this thesis is a study in enhanced symbology, we were especially interested in the effects of presentation mode. Consequently, we made statistical decisions as to whether the null hypothesis should be rejected or not rejected for each Measure of Effectiveness using the presentation mode calculations shown in Tables II-VI. These decisions are discussed below based on a confidence level of 90 percent (or a significance level of 0.10).

1. MOE 1

Recall that the null hypothesis for MOE 1 was there is no difference in present situation correct response time between conventional and enhanced friendly symbology. Referring to Table II, we see that presentation mode has an F-value of 35.80 and significance very nearly equal to zero. We can therefore reject the null hypothesis with virtually 100 percent confidence. Looking then at the main effect of presentation mode, it can be seen that the enhanced symbology had a mean time of 138.3 seconds, over 100 seconds, or 43 percent, faster than conventional. Thus for this MOE, the enhanced friendly symbology was superior to the conventional.

Experience also proved statistically significant with combat-unit-experienced officers performing some 27

TABLE II

ANALYSIS FOR MOE 1

```
****************************************************************

                        ANOVA TABLE

SOURCE OF      DF        SS          MS          F        SIG
VARIATION

TOTAL          42    241800      5757.3
ERROR          37    114900      3105.4
MODEL           5    126900     25381.0      8.173   0.00003

EXPERIENCE      1     10169     10169.0      3.274   0.07808
TRIAL NUMBER    1       802       802.3      0.258   0.61410
PRESENTATION    1    111180    111180.0     35.800   0.00000
 MODE
TACTICAL        1      1399      1398.9      0.450   0.50610
 SITUATION
INTERACTION     1      2108      2108.4      0.678   0.41500
 OF MODE AND
 TAC SIT

****************************************************************

  MAIN EFFECT OF EXPERIENCE:
      LEVEL   COUNT           MEAN              STDEV
          1      22       174.9300             59.5349
          2      21       202.4533             89.2281

  MAIN EFFECT OF TRIAL NUMBER:
      LEVEL   COUNT           MEAN              STDEV
          1      22       180.7491             58.0971
          2      21       196.3571             91.7351

  MAIN EFFECT OF PRESENTATION MODE:
      LEVEL   COUNT           MEAN              STDEV
          1      21       240.8210             74.7838
          2      22       138.3064             28.4850

  MAIN EFFECT OF TACTICAL SITUATION:
      LEVEL   COUNT           MEAN              STDEV
          1      21       180.9738             66.1094
          2      22       195.4332             85.1188
```

seconds faster than combat-support-unit-experienced. This is not surprising since infantry and armor officers are probably more accustomed to the tasks required by the experiment than artillery or air-defense artillery officers.

Trial number, tactical situation and the interaction of presentation mode and tactical situation were not statistically significant. Hence, the enhanced friendly symbology performed equally well regardless of which trial or which tactical situation it was tested in.

2. MOE 2

Similar to MOE 1, the null hypothesis for MOE 2 was there is no difference in present situation correct response time between conventional and enhanced enemy symbology. Referring to Table III, we again see that presentation mode is statistically significant and we reject the null hypothesis with nearly 100 percent confidence. The table shows that enemy enhanced symbology had a mean time of 221.5 seconds, about 81 seconds (or 27 percent) faster than conventional. Thus for this MCE, enhanced enemy symbology was superior to conventional, just as in the friendly symbology case.

However, this time experience was not significant (though level 1 officers still performed faster on the average than level 2) but trial number and tactical situation were. Because the order of the presentation mode was altered for each trial of the experiment, the significance of these variables is not due to symbology. Rather, it appears there was some learning by the subjects in how to quickly answer the enemy situation questions since their second trial was roughly 33 seconds faster on the average than their first. Further, the defensive tactical situation questions were probably somewhat easier to answer than the offensive. Despite these factors, the randomness of presentation mode, tactical situation and trial number ensured the effects of the symbology were independent of the other variables.

TABLE III

ANALYSIS FOR MOE 2

```
*******************************************************

                      ANOVA TABLE

SOURCE OF     DF         SS          MS          F        SIG
VARIATION

TOTAL         42     275070      6549.3
ERROR         37     169110      4570.6
MODEL          5     105960     21192.0      4.637    0.00220

EXPERIENCE     1       4701      4701.3      1.029    0.31670
TRIAL NUMBER   1      15517     15517.0      3.395    0.07300
PRESENTATION   1      77138     77138.0     16.880    0.00020
 MODE
TACTICAL       1      14382     14382.0      3.147    0.08389
 SITUATION
INTERACTION    1        134       134.1      0.029    0.86490
 OF MODE AND
 TAC SIT

*******************************************************

  MAIN EFFECT OF EXPERIENCE:
       LEVEL   COUNT          MEAN              STDEV
           1      22      251.9527            69.2682
           2      21      270.7029            92.3406

  MAIN EFFECT OF TRIAL NUMBER:
       LEVEL   COUNT          MEAN              STDEV
           1      22      277.4814            92.9354
           2      21      243.9586            63.8834

  MAIN EFFECT OF PRESENTATION MODE:
       LEVEL   COUNT          MEAN              STDEV
           1      21      302.5876            72.8819
           2      22      221.5173            68.3904

  MAIN EFFECT OF TACTICAL SITUATION:
       LEVEL   COUNT          MEAN              STDEV
           1      21      279.0662            84.9788
           2      22      243.9695            74.7728
```

3. MOE 3

Back to friendly symbology, the null hypothesis for MOE 3 was there is no difference in accuracy of initial response between conventional and enhanced friendly symbology. Table IV shows that presentation mode is not

TABLE IV
ANALYSIS FOR MOE 3

```
*****************************************************

                      ANOVA TABLE

SOURCE OF     DF          SS          MS         F       SIG
VARIATION

TOTAL         42          56          1.3
ERROR         37          38          1.0
MODEL          5          18          3.5     3.380   0.01295

EXPERIENCE     1           0          0.1     0.079   0.78060
TRIAL NUMBER   1           1          1.0     1.004   0.32260
PRESENTATION   1           3          2.8     2.699   0.10840
  MODE
TACTICAL       1          13         12.9    12.380   0.00112
  SITUATION
INTERACTION    1           0          0.0     0.002   0.96820
 OF MODE AND
 TAC SIT

*****************************************************

  MAIN EFFECT OF EXPERIENCE:
       LEVEL   COUNT          MEAN            STDEV
         1       22          9.0455            1.2527
         2       21          8.9524            1.0713

  MAIN EFFECT OF TRIAL NUMBER:
       LEVEL   COUNT          MEAN            STDEV
         1       22          9.1818            1.0527
         2       21          8.8095            1.2498

  MAIN EFFECT OF PRESENTATION MODE:
       LEVEL   COUNT          MEAN            STDEV
         1       21          8.7143            1.3470
         2       22          9.2727             .8827

  MAIN EFFECT OF TACTICAL SITUATION:
       LEVEL   COUNT          MEAN            STDEV
         1       21          9.5714             .8106
         2       22          8.4545            1.1843
```

statistically significant, exactly as we expected, and we cannot reject the null hypothesis. Regardless of which symbology used, the information to correctly answer any question was available to the subject. However, as the analysis for MOE 1 demonstrated, the correct answer can be arrived at in much less time using enhanced friendly symbology.

Tactical situation was the only significant variable for this MOE. The offensive tactical situation had a mean score about one point higher that the defensive. Since there were only ten friendly situation questions, we can draw no specific conclusion from this outcome.

4. MOE 4

Turning to enemy symbology, the null hypothesis for MOE 4 was there is no difference in accuracy of initial response between conventional and enhanced enemy symbology. Table V contains the results of the analysis for this MOE. Just as with MOE 3, presentation mode is not significant and we cannot reject the null hypothesis. Though there is no difference in accuracy, the response time was much faster with enhanced enemy symbology as explained above.

Similar to the analysis of MOE 2, trial number was significant here. Since the mean score for the second trial was higher than the first, we again attribute this to the subjects learning how to accurately answer the enemy situation questions.

5. MOE 5

Finally, the null hypothesis for MOE 5 was there is no difference in tactical decision response time between conventional and enhanced symbology. We believe that this MOE is the most important test of the enhanced symbology. This symbology was designed to permit the commander to rapidly and accurately extract important tactical information from a situation display. Thus the outcomes of the previous four analyses certainly come as no surprise. But the real value, if any, of enhanced symbology will become evident if it can allow a commander to reach a tactical

TABLE V

ANALYSIS FCR MOE 4

```
*****************************************************************

                            ANOVA TABLE

SOURCE OF      DF          SS          MS          F        SIG
VARIATION

TOTAL          42          57          1.3
ERROR          37          49          1.3
MODEL           5           8          1.6      1.211    0.32310

EXPERIENCE      1           0          0.5      0.369    0.54730
TRIAL NUMBER    1           4          4.0      3.052    0.08850
PRESENTATION    1           3          2.5      1.926    0.17310
 MODE
TACTICAL        1           1          1.2      0.944    0.33710
 SITUATION
INTERACTION     1           0          0.1      0.061    0.80560
 OF MODE AND
 TAC SIT

*****************************************************************

  MAIN EFFECT OF EXPERIENCE:
       LEVEL   COUNT          MEAN            STDEV
           1      22        6.4545           1.0108
           2      21        6.6667           1.3166

  MAIN EFFECT OF TRIAL NUMBER:
       LEVEL   COUNT          MEAN            STDEV
           1      22        6.2727           1.0771
           2      21        6.8571           1.1952

  MAIN EFFECT OF PRESENTATION MODE:
       LEVEL   COUNT          MEAN            STDEV
           1      21        6.3333           1.1547
           2      22        6.7727           1.1519

  MAIN EFFECT OF TACTICAL SITUATION:
       LEVEL   COUNT          MEAN            STDEV
           1      21        6.3810           1.0235
           2      22        6.7273           1.2792
```

decision faster than he could with conventional, even though he develops an understanding or a knowledge of the situation over time and may already know much of the displayed information.

TABLE VI

ANALYSIS FOR MOE 5

```
*****************************************************************

                         ANOVA TABLE

SOURCE OF      DF          SS            MS          F        SIG
VARIATION

TOTAL          42      241320        5745.7
ERROR          37      213830        5779.1
MODEL           5       27493        5498.6      0.952    0.45980

EXPERIENCE      1        1509        1509.3      0.261    0.61220
TRIAL NUMBER    1        1059        1059.4      0.183    0.67090
PRESENTATION    1       21421       21421.0      3.707    0.06151
 MODE
TACTICAL        1         349         349.2      0.060    0.80710
 SITUATION
INTERACTION     1        3771        3771.0      0.653    0.42410
 OF MODE AND
 TAC SIT

*****************************************************************

  MAIN EFFECT OF EXPERIENCE:
       LEVEL  COUNT            MEAN             STDEV
           1     22        175.8532             83.9426
           2     21        185.7476             67.9320

  MAIN EFFECT OF TRIAL NUMBER:
       LEVEL  COUNT            MEAN             STDEV
           1     22        183.8882             82.1423
           2     21        177.3300             70.4144

  MAIN EFFECT OF PRESENTATION MODE:
       LEVEL  COUNT            MEAN             STDEV
           1     21        203.4024             81.2150
           2     22        159.0009             64.8150

  MAIN EFFECT OF TACTICAL SITUATION:
       LEVEL  COUNT            MEAN             STDEV
           1     21        177.4252             69.0154
           2     22        183.7973             83.2728
```

In the experiment, we carefully simulated this knowledge development process. Recall that the data for MOE 5 was gathered during Phase III of each experiment trial. The subject had already been through the two preceding phases of the same operation with the same units and had read all the message traffic with no time limits imposed. He had seen his and his opponent's units make contact, maneuver and suffer gains and losses. When he entered Phase III, he knew the locations of his units and enemy units, and the current status of each. He had developed an understanding of the situation over time.

The value of enhanced symbology is illustrated in Table VI. The only statistically significant variable is presentation mode with the enhanced symbology performing about 44 seconds, or 22 percent, faster than conventional, on the average. We can therefore reject the null hypothesis and state with at least 90 percent confidence that the enhanced symbology permits faster tactical decisions. As the calculations in Table VI further show, this statement is valid irrespective of experience, trial number, tactical situation or the interaction of presentation mode and tactical situation.

D. SUBJECTIVE JUDGEMENTS

The candid responses obtained from each subject via a post-experiment questionnaire were highly supportive of both the design and information content contained in the enhanced symbology portrayed. Where appropriate, the numbers of yes and no responses for each question were summed and comments extracted from the questionnaires to evaluate the usefulness or identify deficiencies for the enhanced tactical symbology. Selected findings will be discussed in more detail in the following paragraphs which address learning, friendly and enemy enhanced symbology, clutter and identified advantages and disadvantages. A summary of the results of the questionnaire is contained in Appendix I.

The responses of experiment participants indicated no difficulty in learning the enhanced symbol set. Subjects indicated that the information presented was logically displayed, simple and easy to understand. The use of bars to represent critical information was very well accepted and the subjects felt the use of simple geometric symbol shapes aided search and understanding. All subjects concluded that there was no difficulty in learning the enhanced tactical symbology.

Results regarding both friendly and enemy enhanced symbology dealt with the amount of information presented, the ability of the subject to read or understand the displayed information and the subjects preference to select or tailor the information desired. All 22 subjects indicated that they were not overwhelmed by the amount or type of information presented. Twenty responded that the amount of friendly and enemy information portrayed was sufficient. These responses support our design criteria in that the enhanced symbology comfortably presented all information clearly, without causing information overflow to the user.

Of concern was the response of 10 subjects having trouble reading or understanding some of the friendly information displayed and of 5 subjects having difficulty reading enemy information. However, their comments clearly indicated that the enhanced symbology did not present an understanding or a reading problem in itself. Legibility difficulty was encountered only in very few instances where tactical control measures crossed a symbol or where unclear portions of the map background caused a symbol to be slightly distorted.

Display clutter was of special interest in both the design and evaluation of the enhanced symbology. Only 4 participants felt the tactical situation displays appeared overly cluttered. It should be noted that these participants sensed this was mainly due to their first exposure to enhanced symbology and a video display. The large majority of the subjects believed clutter did not exist in the situations presented. These participants felt the enhanced symbology provided much more information with essentially no more obscureness of the video display than conventional symbology.

The relative advantages and disadvantages of the enhanced symbology presented are listed in question 7 of Appendix I. Two advantages of the enhanced symbology which clearly stood out from subject comments were:

- decisions could be made easier and within a shorter time span and
- all the information could be displayed simultaneously.

Participants replied that the ability to make a decision within a shorter time frame was the result of the presentation of available information at one time providing an accurate picture of the situation to the commander. The majority of the subjects did not support selective recall of information as they suspected decisions would be made with less than all the information that could be made available to the commander. The simultaneous display of all information provides the commander a complete status of his units as well as the ability to compare units.

In short, the enhanced symbology was positively received, easily learned and understood, and naturally applied by all twenty-two subjects.

E. CONCLUSIONS

The emphasis of this thesis has been the design and evaluation of an enhanced symbol set for the command and control of ground forces. In Chapter II we developed a partial set that embodies a considerable amount of information not illustrated with conventional symbology, and that subdues the damaging effects of clutter. We ended Chapter II with two questions:

1. Can enhanced symbology be of any value to the commander?
2. Is his performance likely to improve if he uses it?

These questions have been affirmatively answered in this chapter.

An analysis of Measures of Effectiveness 1 through 4 showed us that although a commander can accurately answer his tactical questions with either an enhanced or a conventional system, he can do so in much less time with enhanced symbology. Therefore, we believe enhanced symbology is valuable to a commander.

However, the most important test of enhanced symbology lay in Measure of Effectiveness 5. The analysis of this MOE revealed that a commander can reach tactical decisions faster with enhanced symbology even though he gains an understanding of the situation as it develops over time using conventional symbology. Thus a commander's decision-making process is accelerated with enhanced symbology and this is a key ingredient in improving his performance.

The subjective judgements of the subjects which took part in the experiment were highly supportive of the enhanced symbology set presented. The symbology was easily learned, understood and applied, lending further weight to its value.

Although the enhanced symbol set was not intended to be a complete, totally workable alternative to conventional symbology, it has proven to be a step forward in providing ground force commanders a useful tool with which they can immediately assess their assets and those of their opponents, leading to more responsive decisions.

APPENDIX A

OFFENSIVE SITUATION OPERATION ORDER

Copy No ___ of ___Copies
Task Force 2-8, 2d Bde
Grossen, NB462172
011915A Feb 1985

OPORD 1-85

REFERENCE: Map Series, M745 Germany, Sheets L5322 (Lauterbach) and L5342 (Hunfeld), 1:50,000 Edition 1.

TIME ZONE THROUGHOUT THE ORDER: Alpha

TASK ORGANIZATION:

Team Alpha
A/2-8 Mech(-)
1/D/1-3 Armor

Team Delta
D/1-3 Armor(-)
1/A/2-8 Mech
2/B/2-8 Mech
2 AT Sec
2 AVLB

Company B
B/2-8 Mech(-)

TF Con
1/A/52 Engr (DS)
Scout Plt
Hvy Mort Plt
AT Plt(-)

Company C
C/2-8 Mech
AT Sec

1. SITUATION

a. Enemy Forces

(1) Bn is opposed by elements of the 283d Motorized Rifle Regt and the 278th Medium Tank Regt. Motorized rifle platoon sized elements occupy defensive positions vic NB498217, NB506205 and NB510195; a tank company is located

near NB596203. A motorized rifle company occupies Hill 525 (NB577213). Enemy forces in zone are estimated at 75% strength in personnel and 80% in equipment.

(2) Enemy is capable of employing nuclear weapons as large as 10kT by air and ground delivery means.

(3) Indications are that enemy will delay in present and successive positions.

b. Friendly Forces

(1) 2d Bde attacks 020615 Feb 85 to seize high ground vic Hill 365 (NB5020), 525 (NB5721), 553 (NB5918) and Hills 343 (NB5217), 360 (NB5717) and 479 (NB6017).

(2) 3d Brigade attacks 020615 Feb 85 to seize high ground vic Hill 455 (NB6041) - Ufhausen (NB6025) to the north.

(3) TF 1-8 attacks 020615 Feb to seize high ground vic Hill 343 (NB5217), 479 (NB6017) and 539 (NB6115) to the south.

(4) TF 3-8, Bde reserve, follows TF 2-8 on order, is prepared to seize or assist in seizure of Hills 365 (NB5020), 351 (NB5119), 525 (NB5721) and 553 (NB5918).

(5) 1-19 Field Artillery DS 2d Bde.

(6) A/52 Engr DS 2d Bde.

c. Attachments and Detachments. Task Organization.

2. MISSION. TF 2-8 attacks 020615 Feb 85 to seize Hills 365 (NB5020) - 351 (NB5119), Hills 429 (NB5520) - 518 (NB5619) and Hills 525 (NB5721) - 553 (NB5918).

3. EXECUTION

a. Concept of Operations. Annex B (Operations Overlay). TF 2-8 attacks with Team D making the main attack to seize OBJ A (NB5020), continuing the attack to seize OBJ C (NB5520) and OBJ E (NB5721). Company C makes a supporting attack, passing through Company B(-) to seize OBJ B (NB5020), continuing the attack to seize OBJ D (NB5619) and OBJ F (NB5918). Team A and Company B(-), TF reserve, follow Team D and Company C respectively, on order. A 15 minute nonnuclear preparation will be fired commencing H-15. Artillery fires with smoke planned on OBJ's E and F. Priority of artillery fires to Team D. Annex C (Fire Support).

b. Team A. Be prepared to seize or assist in seizure of OBJ's A, C and E.

c. Company B(-)

(1) Move to overwatch position vic NB500182 on order.

(2) Be prepared to seize or assist in seizure of OBJ's B, D and F.

d. Company C. Make supporting attack, passing through Company B(-) to seize OBJ's B, D and F.

e. Team D. Conduct main attack to seize OBJ's A, C and E.

f. Scout Platoon

(1) Recon and secure bridges at NB487213 (Team D) and NB500194 (Company C) NLT 0400 hours.

(2) Recon fording sites across Haune River for tracked vehicles.

(3) Screen TF north flank on order.

g. Heavy Mortar Platoon. GS from NB479186. Displace to NB540199 on order.

h. AT Plt(-). GS, priority of support to attacking units. Follow Team D on order.

j. Coordinating Instructions

(1) Units report crossing PL JIM.

(2) Report immediately any air defense guns with enemy forward units.

(3) Report immediately any dispersal of tank and SP guns with enemy forward units.

(4) Commanders of Co B(-) and Co C coordinate passage of lines.

4. SERVICE SUPPORT

a. General

(1) TF Field Trains located at NB383155.

(2) TF Combat Trains at NB448162.

b. Supply

(1) Class I. Bn SOP

(2) Class V. Combat supply rate - 8 Tow rounds per weapon.

c. Medical. Bde clearing station vic Bde Field Trains. Medevac per SOP.

d. Personnel. Prisoner of War collection point 200m forward of combat trains.

5. COMMAND AND SIGNAL

a. Signal

(1) CEOI Index 1-12.

(2) Emergency signal for lifting prep fires: two red star clusters.

b. Command

(1) Commander located initially vic NB483207 and follows main attack.

(2) CP vic NB463182.

ACKNOWLEDGE

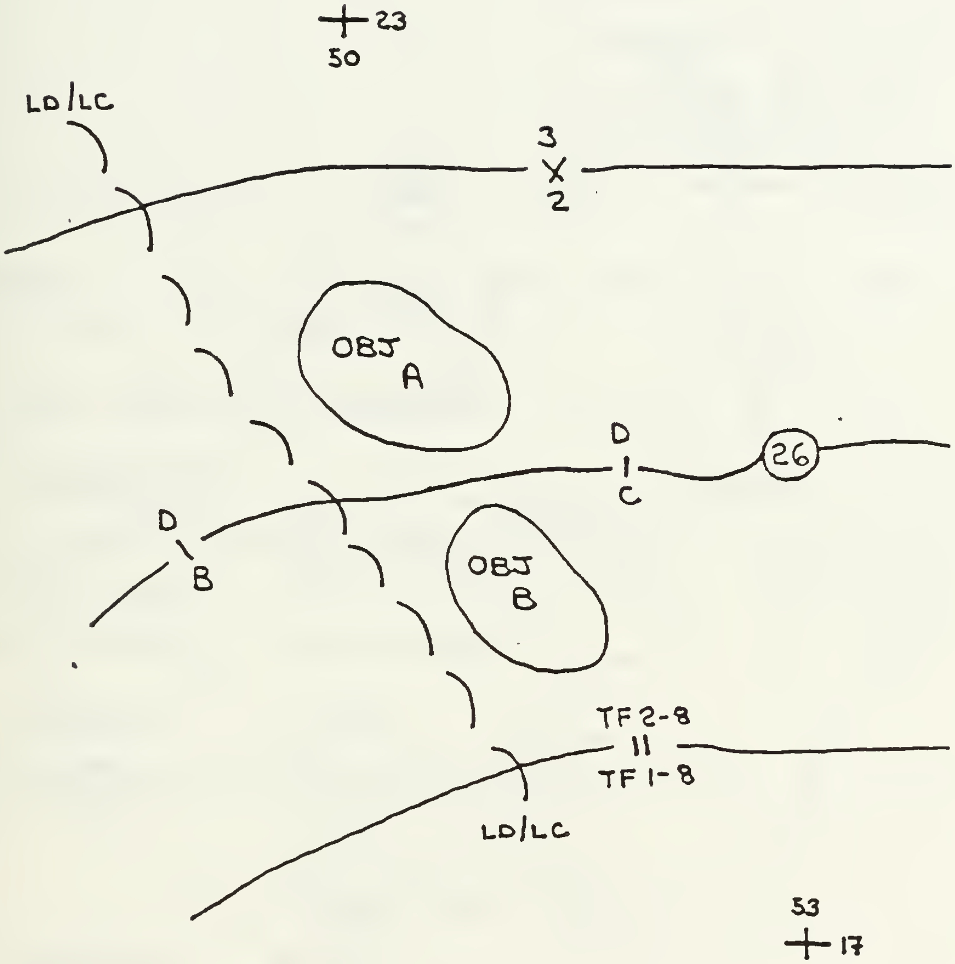
HAWMILL, M. J.
LTC

OFFICAL:

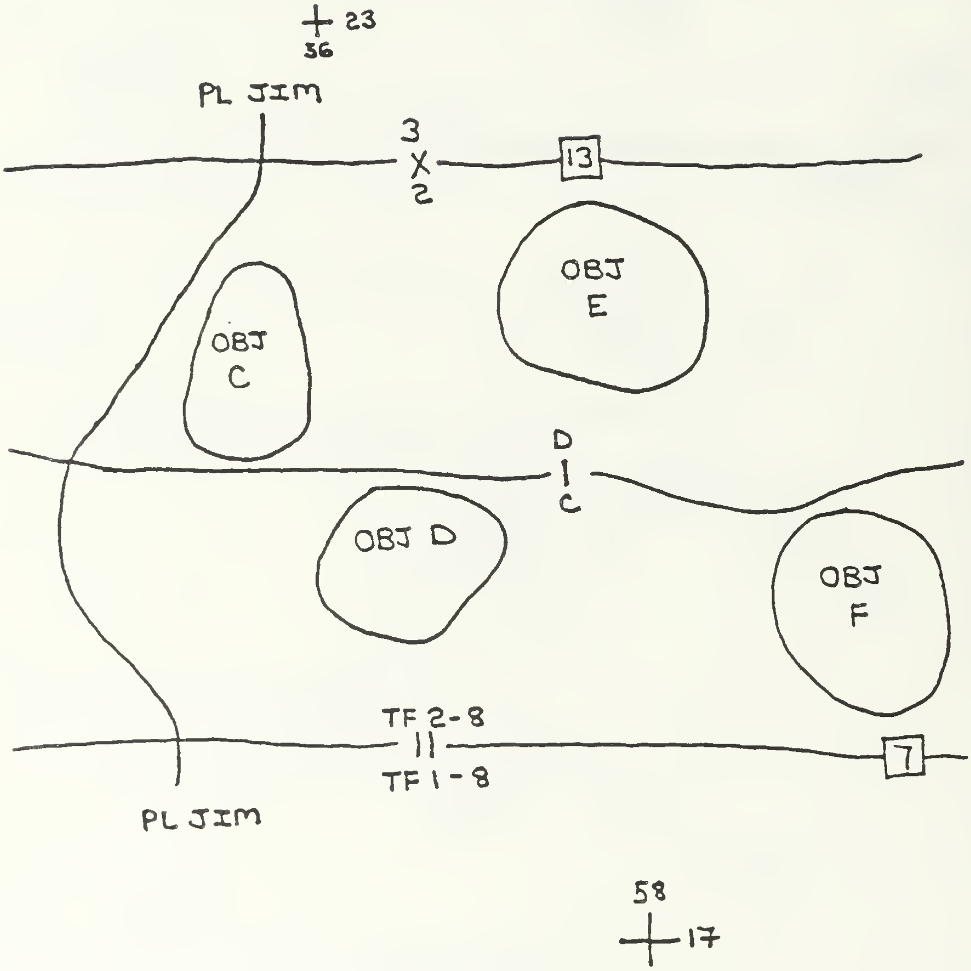
NELSON
S3

Annexes: A-Intelligence (omitted)
B-Operations Overlay
C-Fire Support (omitted)

ANNEX B (OPERATIONS OVERLAY) to OPORD 1-85



ANNEX B (OPERATIONS OVERLAY) to OPORD 1-85



APPENDIX B
DEFENSIVE SITUATION OPERATION ORDER

Copy No ___ of ___Copies
Task Force 2-8, 2d Bde
Reimbolds, NB375300
010300A Feb 1985

OPORD 2-85

REFERENCE: Map Series, M745 Germany, Sheet L5222 (Breitenbach), 1:50,000 Edition 1.

TIME ZONE THROUGHOUT THE ORDER: Alpha

TASK ORGANIZATION:

Team Alpha	Team Delta	Company B
A/2-8 Mech	D/1-3 Armor (-)	B/2-8 Mech
1/D/1-3 Armor	1/C/2-8 Mech	(2) AT Sec

Team Charlie	TF Con
C/2-8 Mech (-)	Scout Plt
AT/2-8 Mech (-)	Hvy Mort Plt
	3/B/54 Engr (DS)
	3/B/580 Engr (Opcon)

1. SITUATION

a. Enemy Forces. Expect a reinforced motorized rifle division of the 5th CAA to attack in the Brigade sector within 72 hours with at least one motorized rifle regiment to conduct the main attack in our sector. The enemy attack will occur most likely along avenue of approach Engelbach (4225) - Machtlos (3428) with a reinforced motorized rifle battalion, and approach Mengshausen (4327) - Hattenbach

(3928) - East-West Autobahn with second reinforced motorized rifle battalion, comprising the 1st echelon. A third reinforced motorized rifle battalion will comprise the 2d echelon. The objective of the enemy attack will most likely be to penetrate our defenses and breakthrough to the brigade rear to the west, with his day's objective being Alsfeld (1922). Enemy elements are equipped with T-72 tanks, BMP's, BRDM's, BRT-60's, ZSU-23-4's, SA-9's and 122mm SP Howitzers (see enemy order of battle) and are believed to be units of the 283d Motorized Rifle Regiment and the 278th Tank Regiment. He has not yet used chemical or nuclear weapons, but is expected to use chemicals and is capable of using both. He is at 90% strength with high morale.

b. Friendly Forces

(1) 2d Bde defends in sector NLT 020600 Feb 1985; controls covering force operation from PL JIM (FEBA) to the east.

(2) 3d Bde defends in sector NLT 020600 Feb 1985 to the north.

(3) TF 1-8 defends in sector NLT 020600 Feb 1985 to the south.

(4) TF 3-8 defends in sector forward of TF 2-8 as part of the covering force.

(5) TF 4-8 occupies positions in the TF 2-8 rear sector, acts as the Bde reserve and counterattack force.

(6) 1-19 Field Artillery (155, SP) Direct Support

(7) 2/54th Chemical Company Direct Support

c. Attachments and Detachments. Task Organization.

2. MISSION. TF 2-8 defends in sector NLT 020600 Feb 1985 from NB410250 to NB435287, accepts control of battle area after assisting withdrawal of the covering force.

3. EXECUTION

a. Concept of Operations. Annex B (Operations Overlay)

(1) Maneuver. TF 2-8 defends with 2 teams forward covering the Fulda River, Team A on the right occupies Battle Position (BP) 1, Team D on the left occupies BP 2 and two teams occupy positions in depth. Team C occupies BP 3 and Co B occupies BP 4. Battle begins after Scouts assist passage of TF 3-8 (covering force) and enemy enters Engagement Area (EA) Red. Tanks will initiate fires from Team D, followed by TOW and Tank flank fires from Team A. It is desired to force the enemy into EA Tan. Once the enemy's momentum has been stopped, be prepared to assist Bde's counterattack or conduct a counterattack with Team A, D or C to destroy enemy follow on forces and restore the FEBA.

(2) Fires. (Annex C) Priority of artillery fires initially to Scout Platoon until it's withdrawal, then to Team D. Priority of 107mm mortar fires to Team A.

(3) Obstacles, Mines and Fortifications. (Annex B). Priority of engineer missions to countermobility, then survivability. Priority of obstacle preparation to left/ right flanks of sector. After completion of forward countermobility obstacles, priority of engineer effort will be to Team A.

b. Team A

(1) Occupy and hold BP 1. Orient fires into EA Red.

(2) Execute obstacle 2301 on order only, when covering force and Scouts have withdrawn.

(3) Be prepared to counterattack by fire to complete destruction of enemy.

(4) Be prepared to assist withdrawal of covering force or Scouts from alternate Passage Lane Jill.

(5) On order, be prepared to displace to BP 5 or 6 and orient fires into EA Tan.

c. Team D

(1) Occupy and defend BP 2 in depth. Orient fires into EA Red and EA Tan.

(2) Be prepared to counterattack by fire to complete destruction of enemy.

(3) On order, be prepared to displace to BP 7.

d. Team C

(1) Occupy BP 3. Orient fires into EA Tan.

(2) Be prepared to counterattack by fire to complete destruction of enemy.

(3) On order, be prepared to displace to BP 7 and orient fires to the southeast.

e. Company B

(1) Occupy BP 4. Orient fires into EA Tan.

f. Scout Platoon

(1) Screen forward of PL JIM (FEBA). Occupy contact points 1 and 2. Establish contact with TF 3-8 and assist their passage.

(2) Conduct passage, screen right flank from NB400253 to NB350278 and establish contact with TF 1-8.

g. Heavy Mortar Platoon

(1) Initially locate NB373274. Priority of fires to Team A. Displace on order to NB353303.

h. 3/B/54th Engineers.

(1) Construct obstacles in accordance with Annex B.

i. Reserve. None.

j. Coordinating Instructions

(1) Report all sightings of enemy bridging equipment.

(2) Be prepared to provide guides to covering force elements in sector.

(3) Mission Oriented Protective Posture 1 (MOPP 1) in effect. TF hasty decon site NB320267, on order.

(4) Air Defense Weapons Status; weapons tight.

(5) Close air support will be controlled on Team Command Net if FAC not available.

(6) Primary Passage Lane is Jack; alternate Jill.

4. SERVICE SUPPORT

a. General

(1) TF Field Trains collocated with Bde at NB274285.

(2) TF Combat Trains at NB345284.

b. Material and Services

(1) Supply. TF SOP.

(2) Transportation. Priority to TF covering force. Release point at combat trains.

(3) Services. TF Graves Registration in Combat Trains. Water Point NB274286.

(4) Maintenance. Organizational Maintenance CP at NB282267.

c. Medical. Bde clearing station NB277285.

d. Personnel. Prisoner of War collection per SOP.

5. COMMAND AND SIGNAL

a. Signal

(1) Radio listening silence in effect until lifted by NCS for units except those actually engaged or involved in passage of lines.

(2) Current CEOI in effect.

b. Command

(1) Commander located initially vic NB403288.

(2) CP vic NB349300, alternate NB339310.

ACKNOWLEDGE

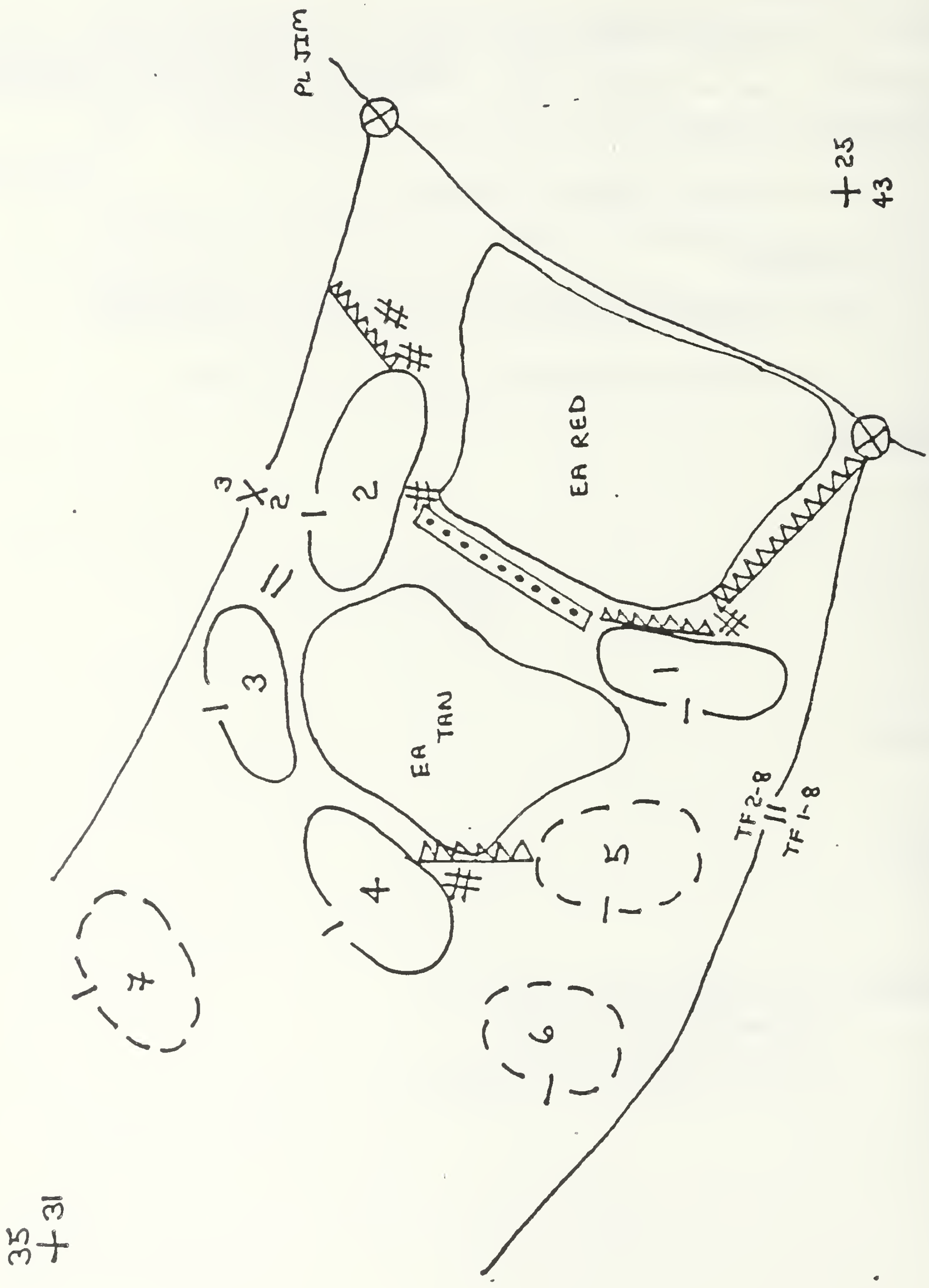
HAWMILL, M. J.
LTC

OFFICAL:

NELSON
S3

Annexes: A-Intelligence (omitted)
B-Operations Overlay
C-Fire Support (omitted)

ANNEX B (OPERATIONS OVERLAY) to OPORD 2-85



APPENDIX C

ENEMY ORDER OF BATTLE

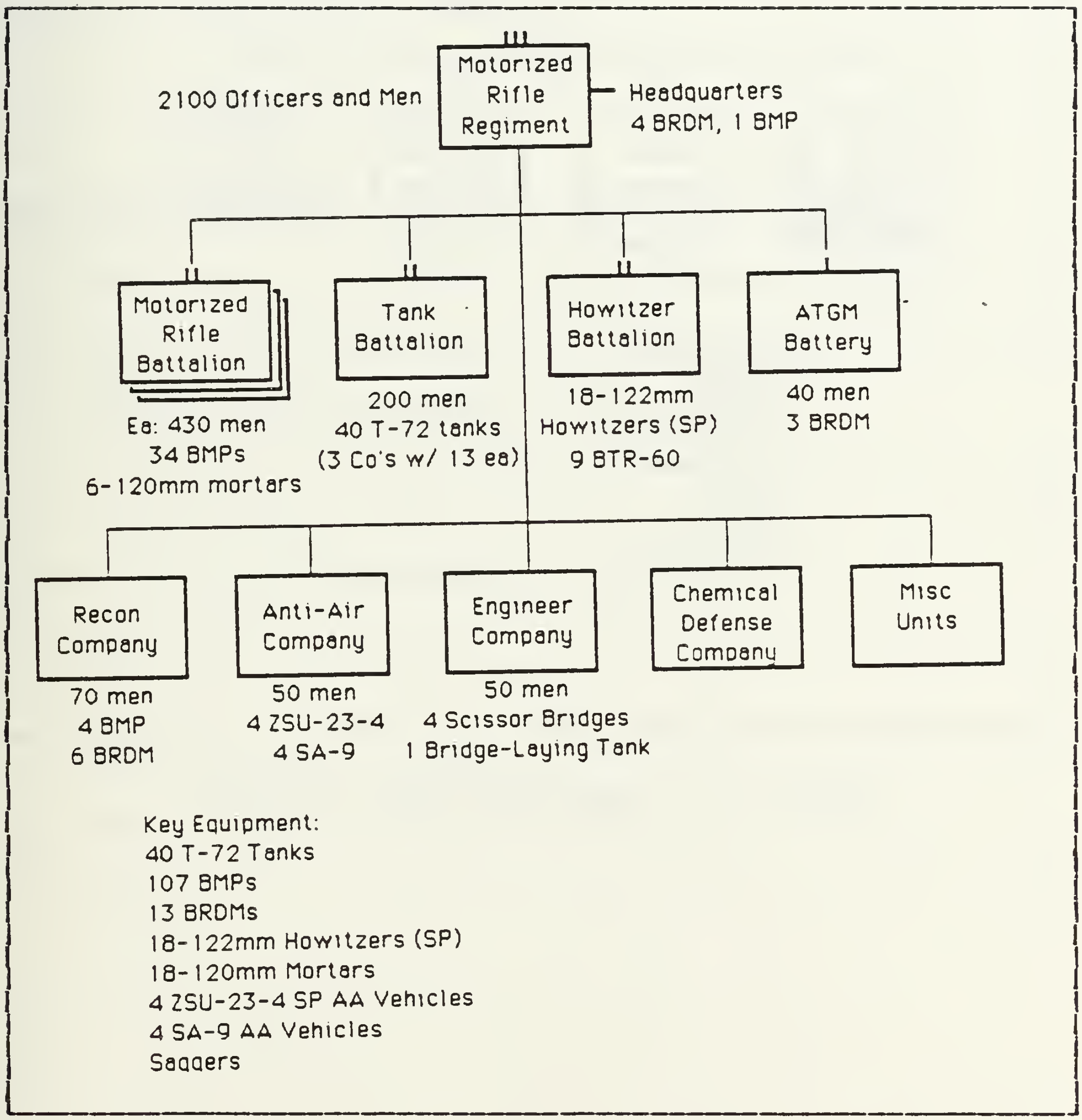


Figure C.1 Motorized Rifle Regiment

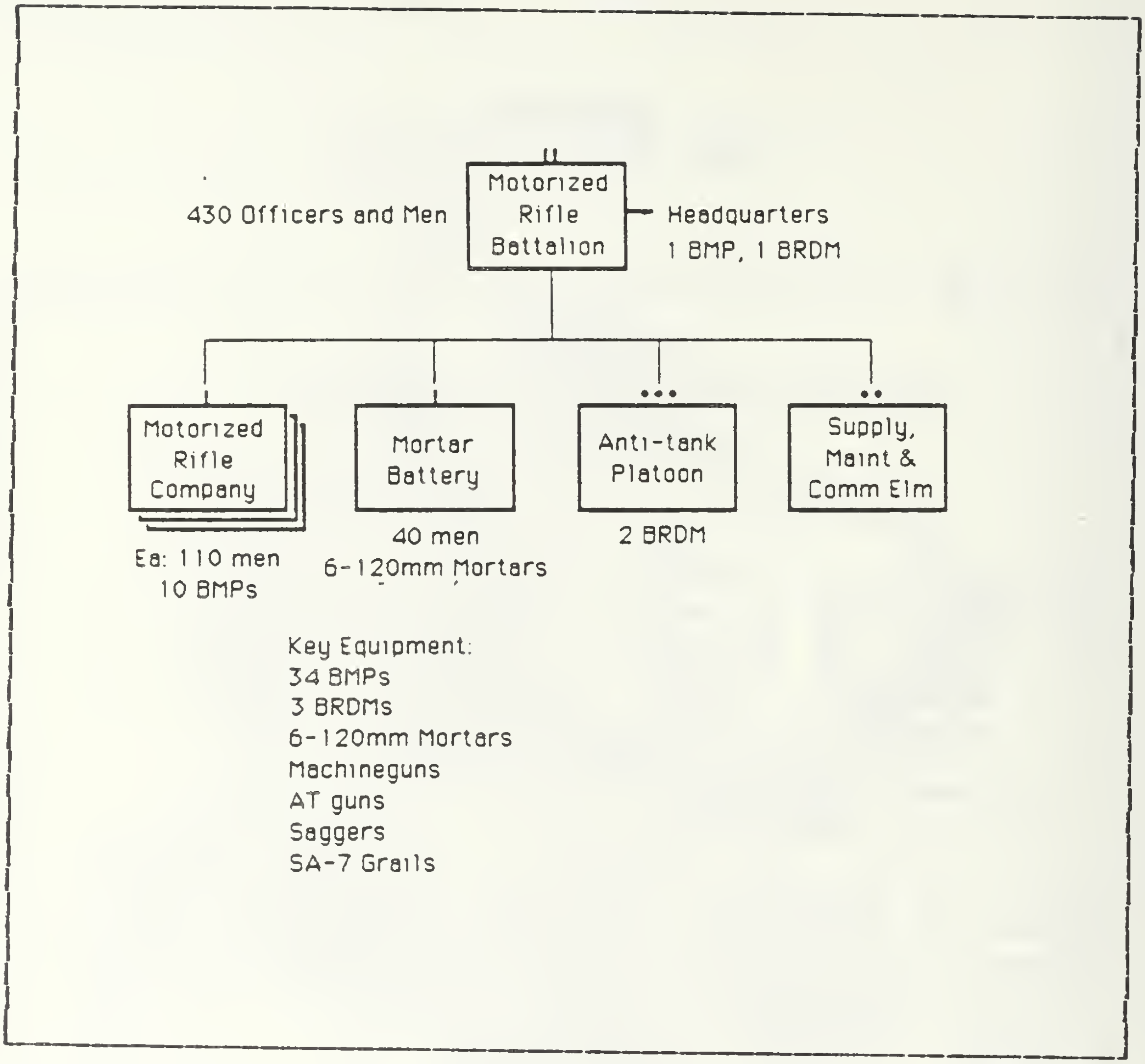


Figure C.2 Motorized Rifle Battalion

APPENDIX D

EXAMPLES OF TACTICAL SITUATION MESSAGE TRAFFIC

This S-1 report provides the basis for emergency replacement action by specialty and grade.

Emergency Personnel Request (EPERSREQ) No ________

1. Unit____

2. DTG____

3. Officers (Grade/MCS/Number required)

____________________/______________/____________________

____________________/______________/____________________

4. Enlisted (Grade/MCS/Number required)

____________________/______________/____________________

____________________/______________/____________________

____________________/______________/____________________

____________________/______________/____________________

5. Reason____

____

This S-1 report provides a basis for routine replacement actions.

Personnel Situation Report (PERSITREP) No ___

1. Unit Co B
2. DTG 012010 Feb 85
3. Strength (Officer/Enlisted/Total)
    a. Authorized 5 / 115 / 120
    b. Assigned 4 / 90 / 94
    c. On hand 3 / 100 / 103
    d. Percent (On hand to Authorized) 85
4. Losses since last report
    a. KIA 0
    b. WIA 0
    c. MIA 0
    d. Nonbattle 0
    e. Total 0
5. Gains since last report
    a. Replacements 6
    b. WIA returned to duty 3
    c. Total 9

This S-2 report provides subordinate commanders with an update of division-wide enemy activity and intentions.

Intelligence Summary Report (INTSUM) No ________

1. Unit S2, TF 2-8

2. DTG 020300 Feb 85

3. Summary of enemy activity Enemy preparing hasty defensive positions on OBJ A & B with PLT sized elements of a reinforced MRC. Expect enemy to delay from OBJ A,B,C & D with deliberate def posn's east of grid 57. Enemy MRB's capabilities include Engr, Chemical & Bridging. Arty units have nuclear capability.

4. Enemy unit identifications (unit/equip/loc/activity)

MRC / Equip-ukn / NB4922 / Delay mission - 3rd Bde sector
MRP / 3-BMP's / NB4921 / Delay mission
MTP / 4-T72's / OBJ A / Delay mission
MRP / 3-BMP's / OBJ A / Delay mission
MRP / 3-BMP's / OBJ B / Delay mission
MRC / Equip-ukn / NB5217 / Delay mission - TF 1-8 sector
MRC / 7-BMP's / OBJ D / Delay mission
MRC / Equip-ukn / NB5722 / Delay mission - 3rd Bde sector
MRC / 7-BMP's / OBJ E / Deliberate def posn
MRP / 3-BMP's / NB5820 / Deliberate def posn
MTC / 7-T72's / NB5920 / Deliberate def posn- reserve
MRC / 5-BMP's / OBJ F / Deliberate def posn
Arty BTY/ 6-122mm how(SP),2-btr60/ NB5921 / Nuclear capability

5. Enemy forward line of troops (FLOT)

Grid NB5122 to NB5218 to ____________

6. Summary of enemy rear activity ____________________

This S-3 report updates the status of a unit's critical combat assets.

Combat Power Report (CBTPWRREP) No ________

1. Unit Co B
2. DTG 011550 Feb 85
3. Personnel Status (Percent of Authorized) 85
4. Tanks (Authorized/Combat Effective) 0 / 0
5. Tows (Authorized/Combat Effective) 2 / 2
6. Dragons (Authorized/Combat Effective) 8 / 8
7. APC's (Authorized/Combat Effective) 9 / 8
8. Mortars (Authorized/Combat Effective) 3 / 2
9. Weapons Status (Percent of Authorized) 92
10. Equipment Status (Percent of Authorized) 86

This S-4 report serves as a requisition for replacement of critical combat equipment or supplies.

Resupply Request (RESUPREQ) No ________

1. Unit Co B
2. DTG 011400 Feb 85
3. Priority EMERGENCY
4. Item required/quantity

MOGAS / 100 gals
DIESEL / 1500 gals
_______________ / _______

5. Delivery/Pick-up point NB 459160
6. Remarks ________________

This S-4 report provides the commander with a unit's logistical status.

Logistics Status Report (LOGREP) No ________

1. Unit Co B

2. DTG 011745 Feb 85

3. Class I (Rations--On hand/Basic load) 1400 / 2400

4. Class III (POL)

   a. Mogas (On hand/Basic load) 80 / 200

   b. Diesel (On hand/Basic load) 950 / 2400

   c. POL Status (Percent of Authorized) 40

5. Class V (Ammunition)

   a. Type/quantity on hand

Tow/Dragon	16/63
50 cal/7.62	18,000/14,000
5.56	10,000
81mm	195

   b. Ammunition Status (On hand to Basic Load) 85

6. Class VII (Command Controlled Items)

Nomen	Auth	On hand	Operational	Loss	Issues
Dragon	8	8	8	0	0
Tow	2	2	2	0	0

7. Remarks

This Commo report is from the communications officer and provides the commander with the communications status of his units.

Communication Status Report (COMMREP) No________

1. Unit TF 2-8

2. DTG 020600 Feb 85

3. Communications Status by Unit

TM A	Up - Secure
Co B	Up - Secure
Co C	Down
TM D	Up - Secure
MTR PLT	Up - Secure
SCT PLT	Up - Secure
AT PLT	Up - Nonsecure

APPENDIX E
PHOTOGRAPHS OF TACTICAL SITUATION DISPLAYS

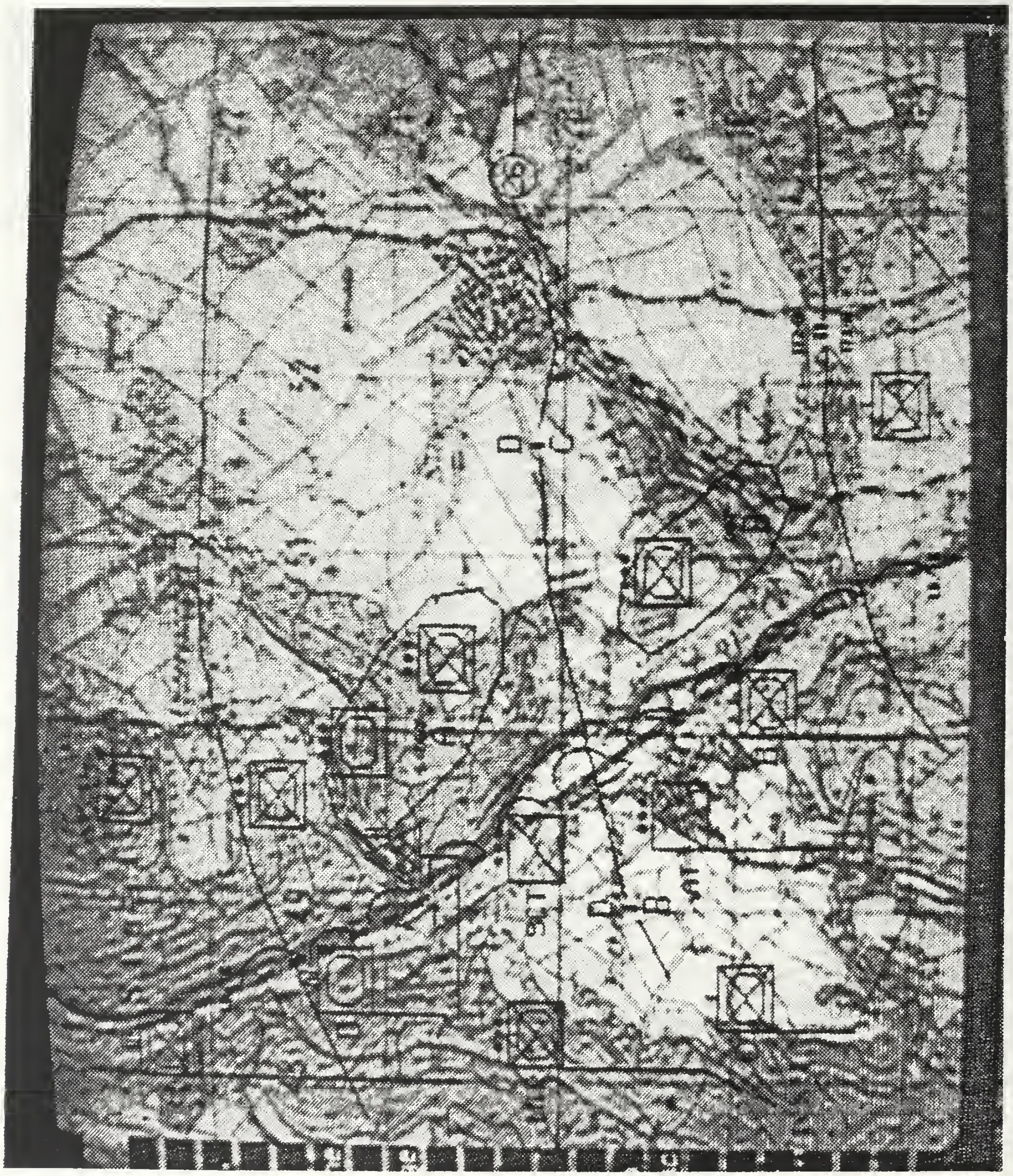


Figure E.1 Phase I Conventional Offensive Display (West Sector).

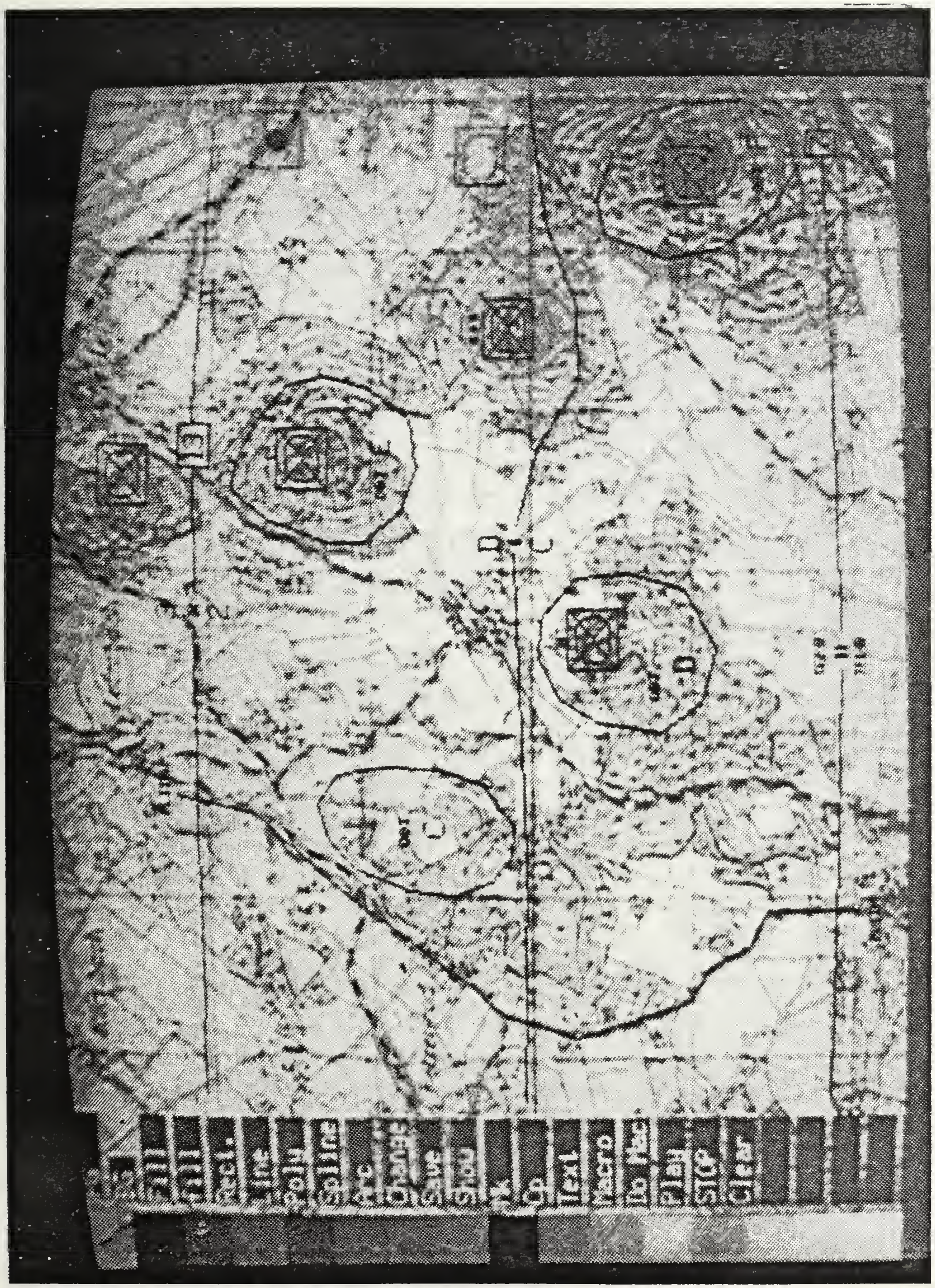


Figure E.2 Phase I Conventional Offensive Display (East Sector).

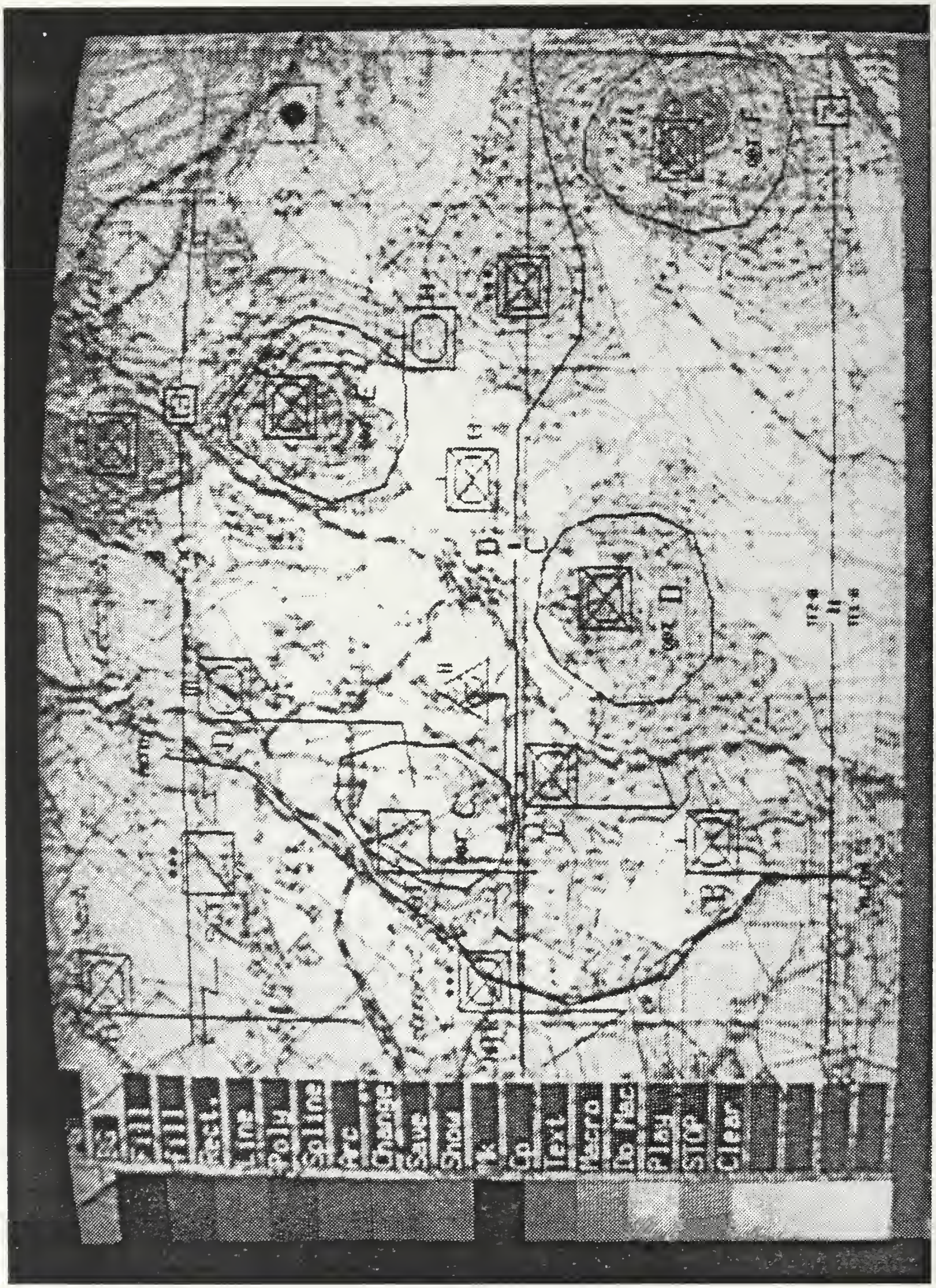


Figure E.3 Phase II Conventional Offensive Display

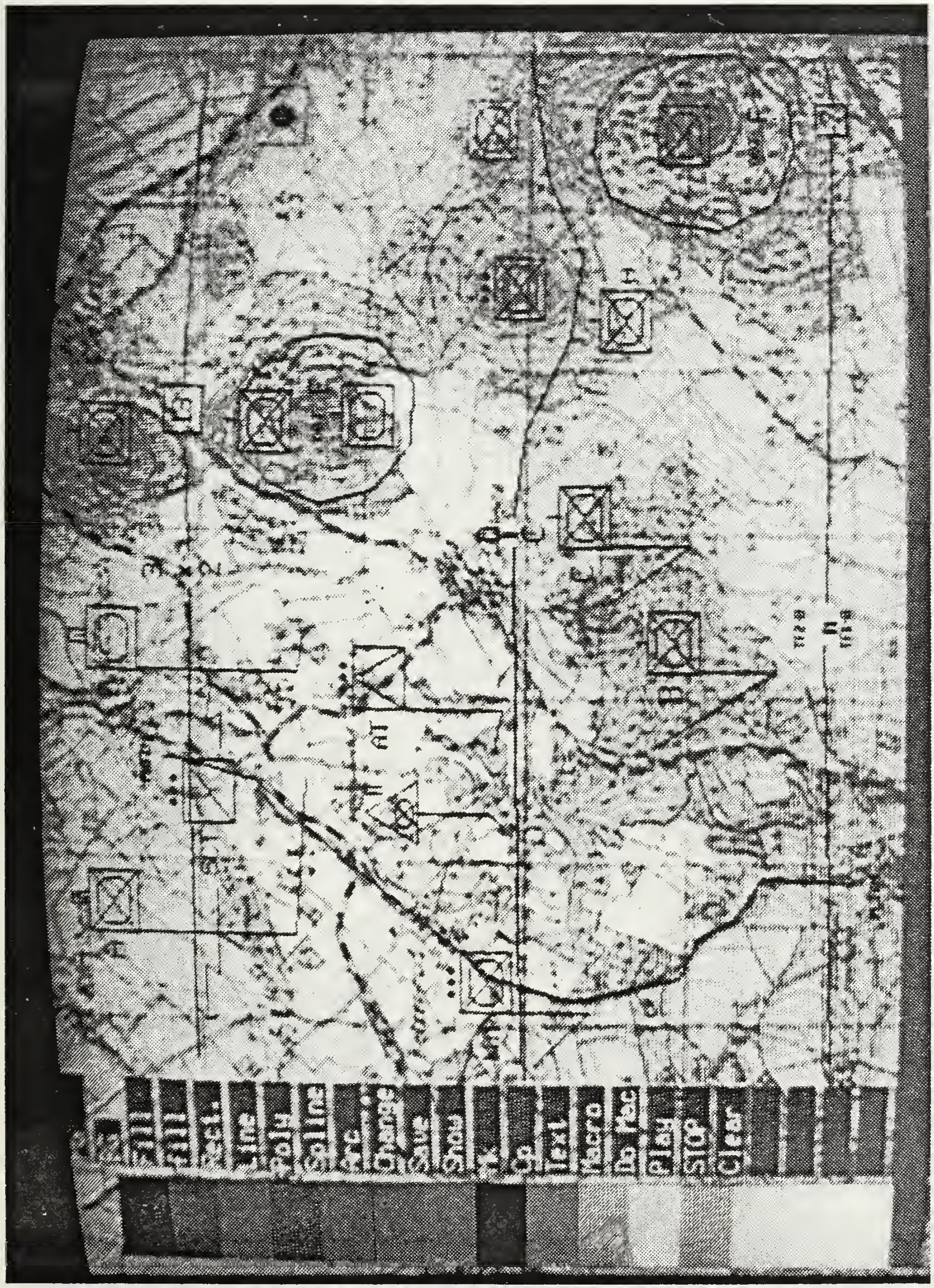


Figure E.4 Phase III Conventional Offensive Display

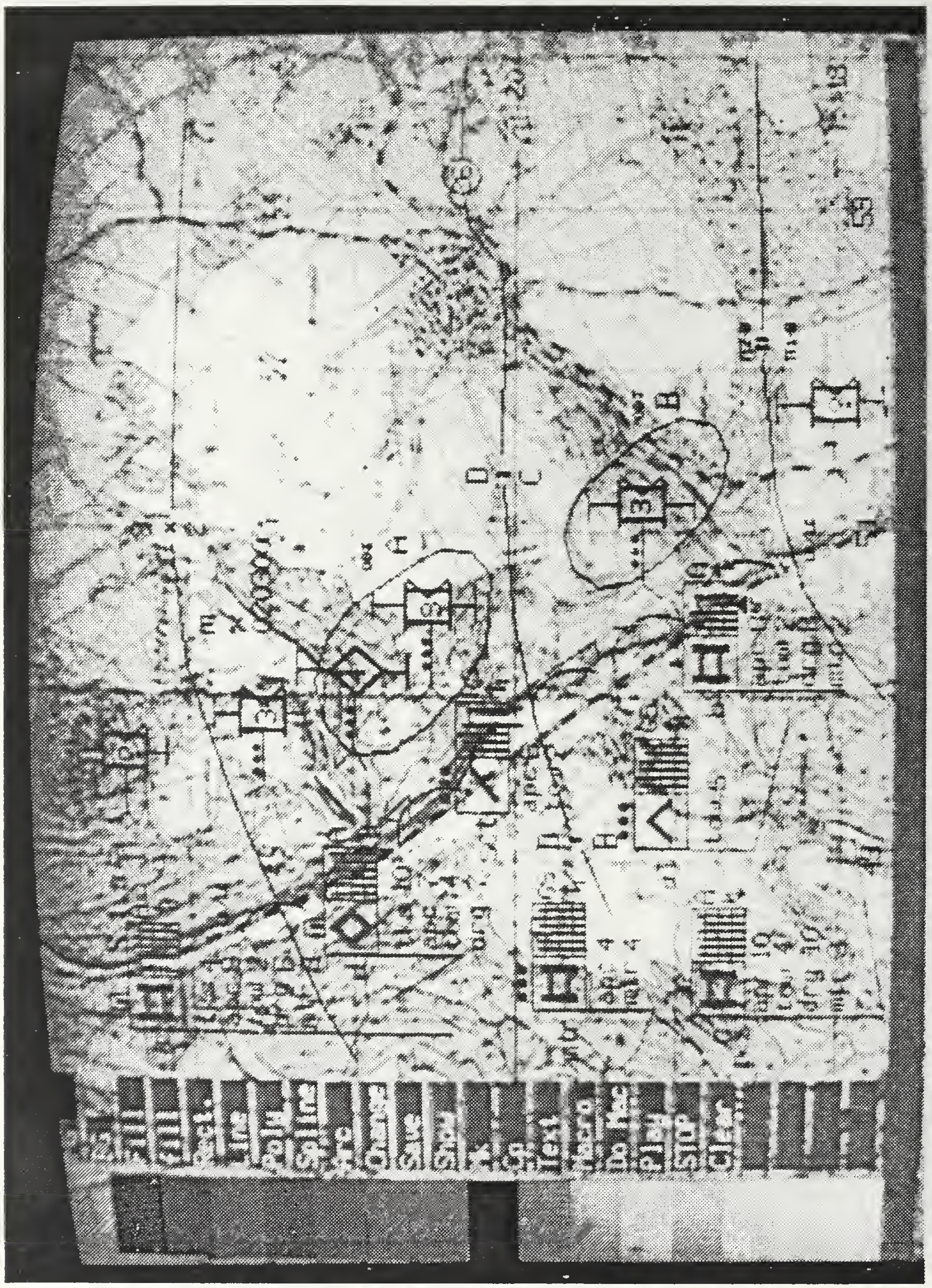


Figure E.5 Phase I Enhanced Offensive Display (West Sector).

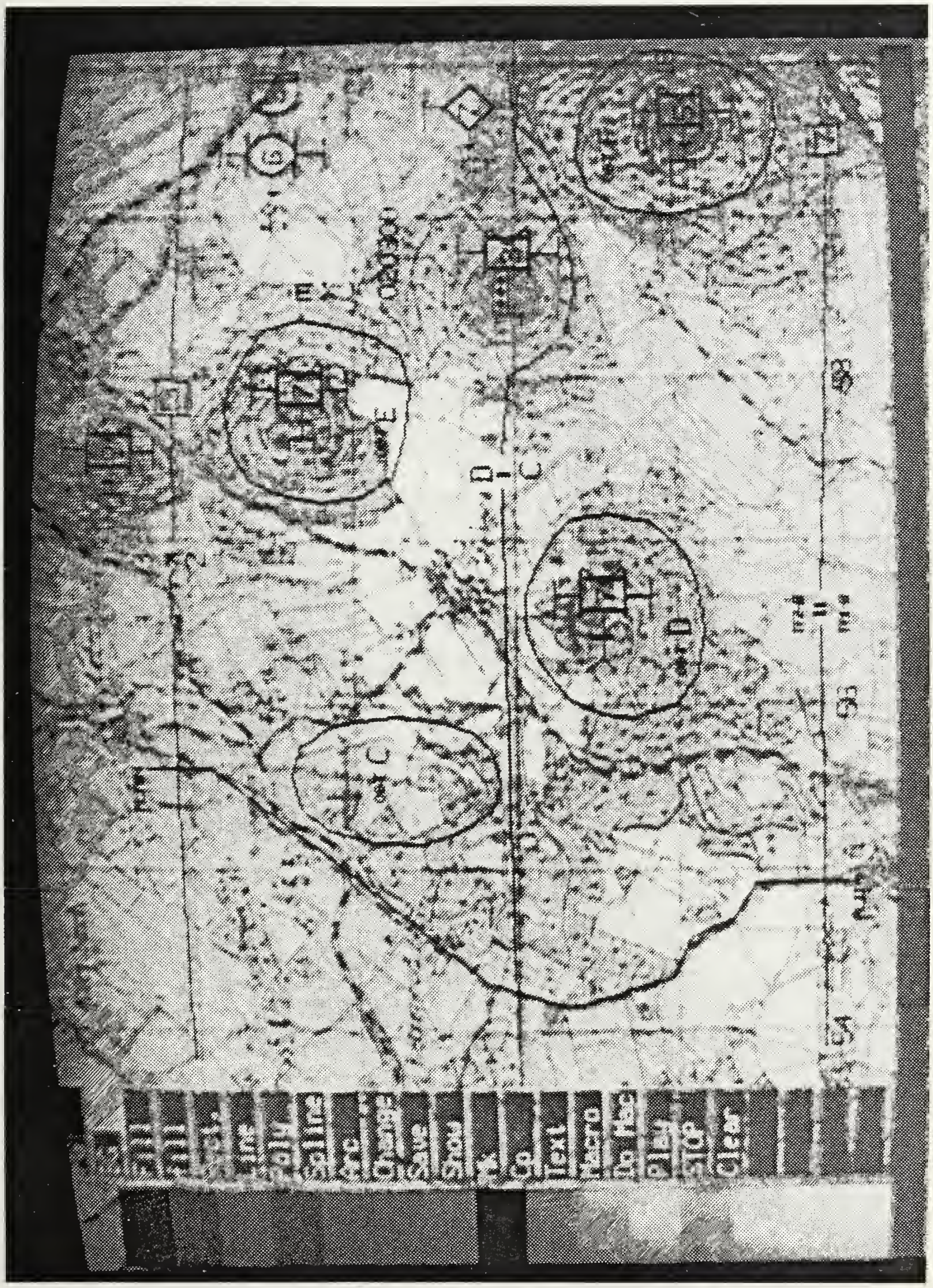


Figure E.6 Phase I Enhanced Offensive Display (East Sector).

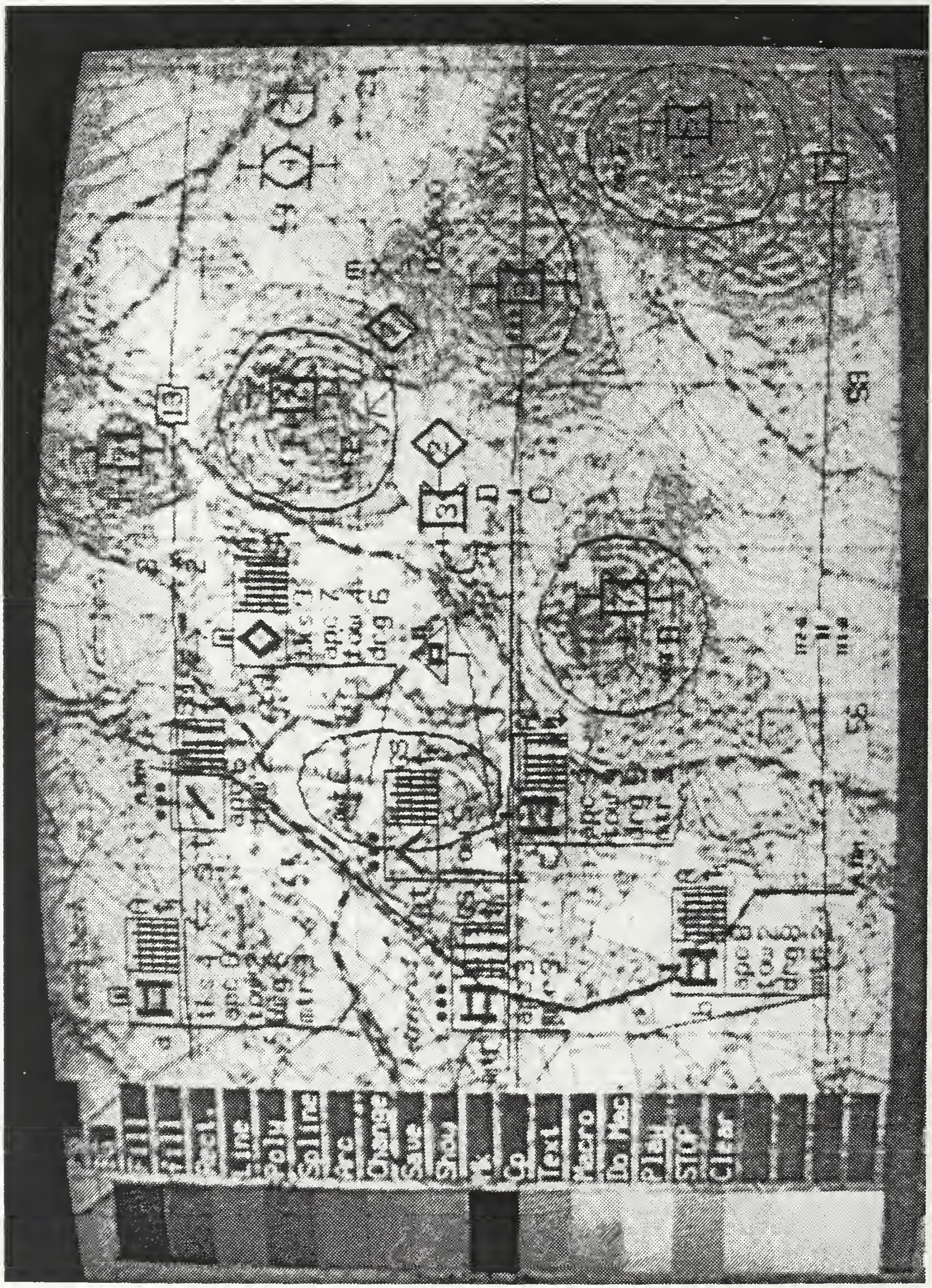


Figure E.7 Phase II Enhanced Offensive Display

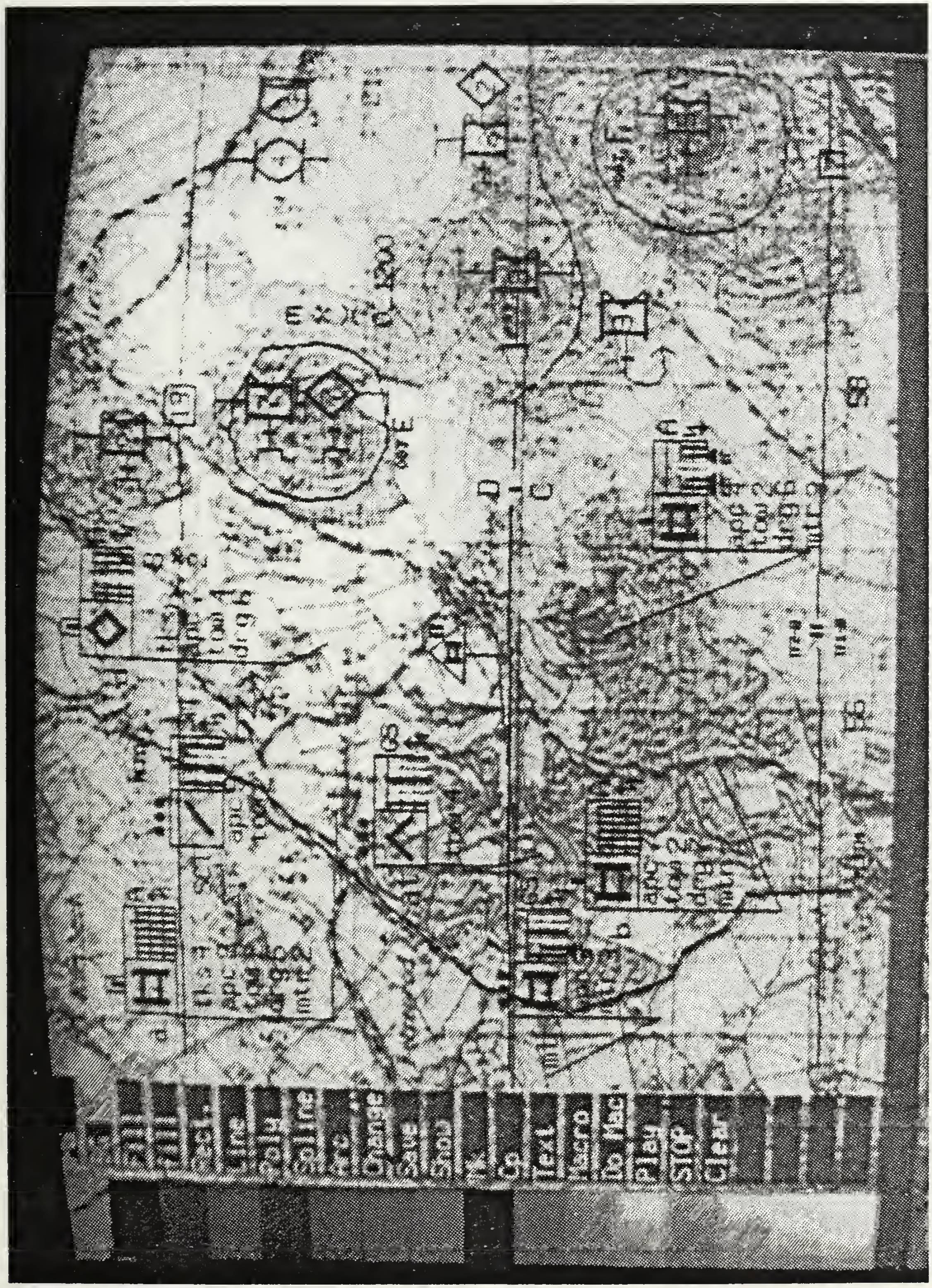


Figure E.8 Phase III Enhanced Offensive Display

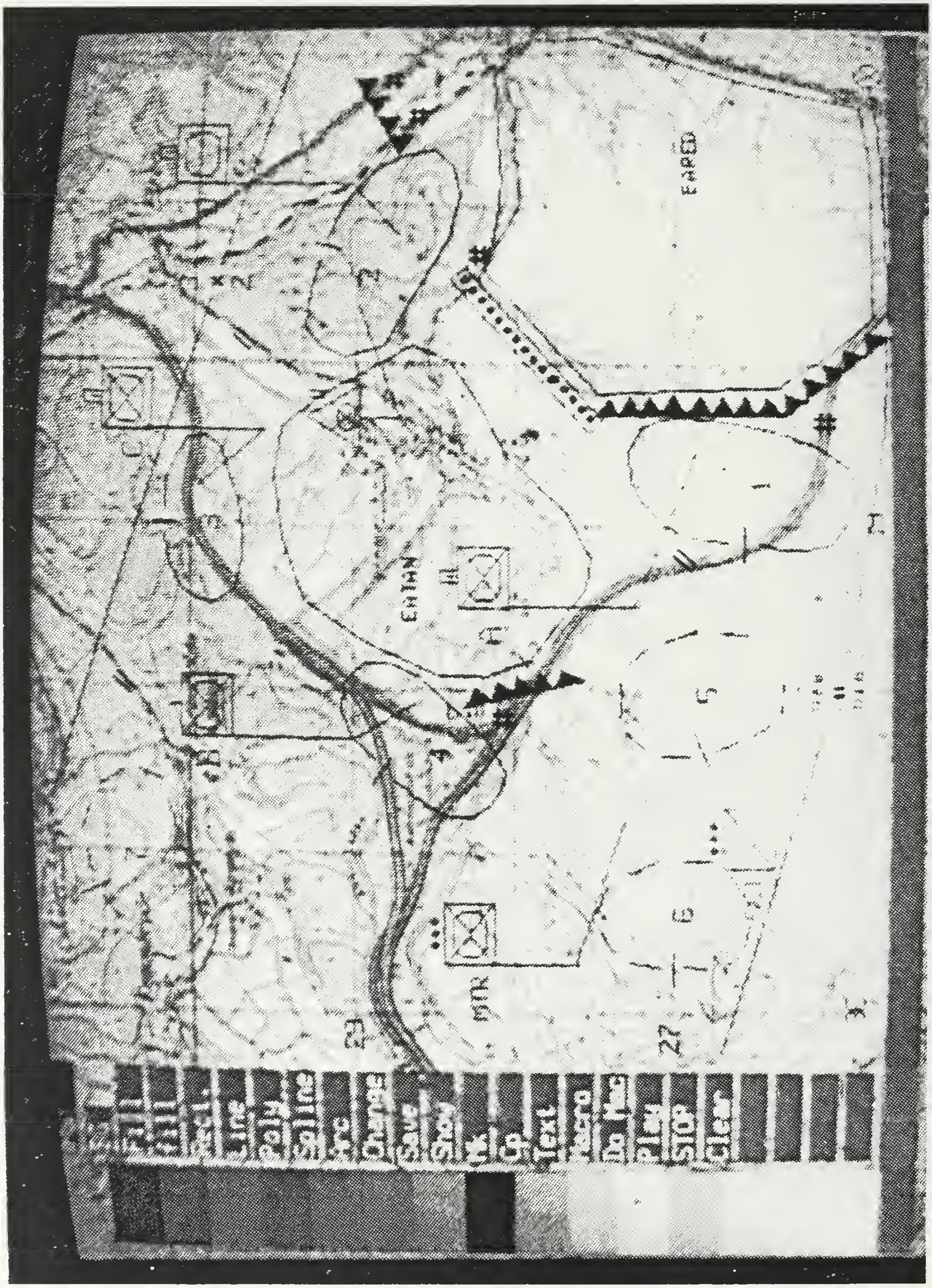


Figure E.9 Phase I Conventional Defensive Display (West Sector).

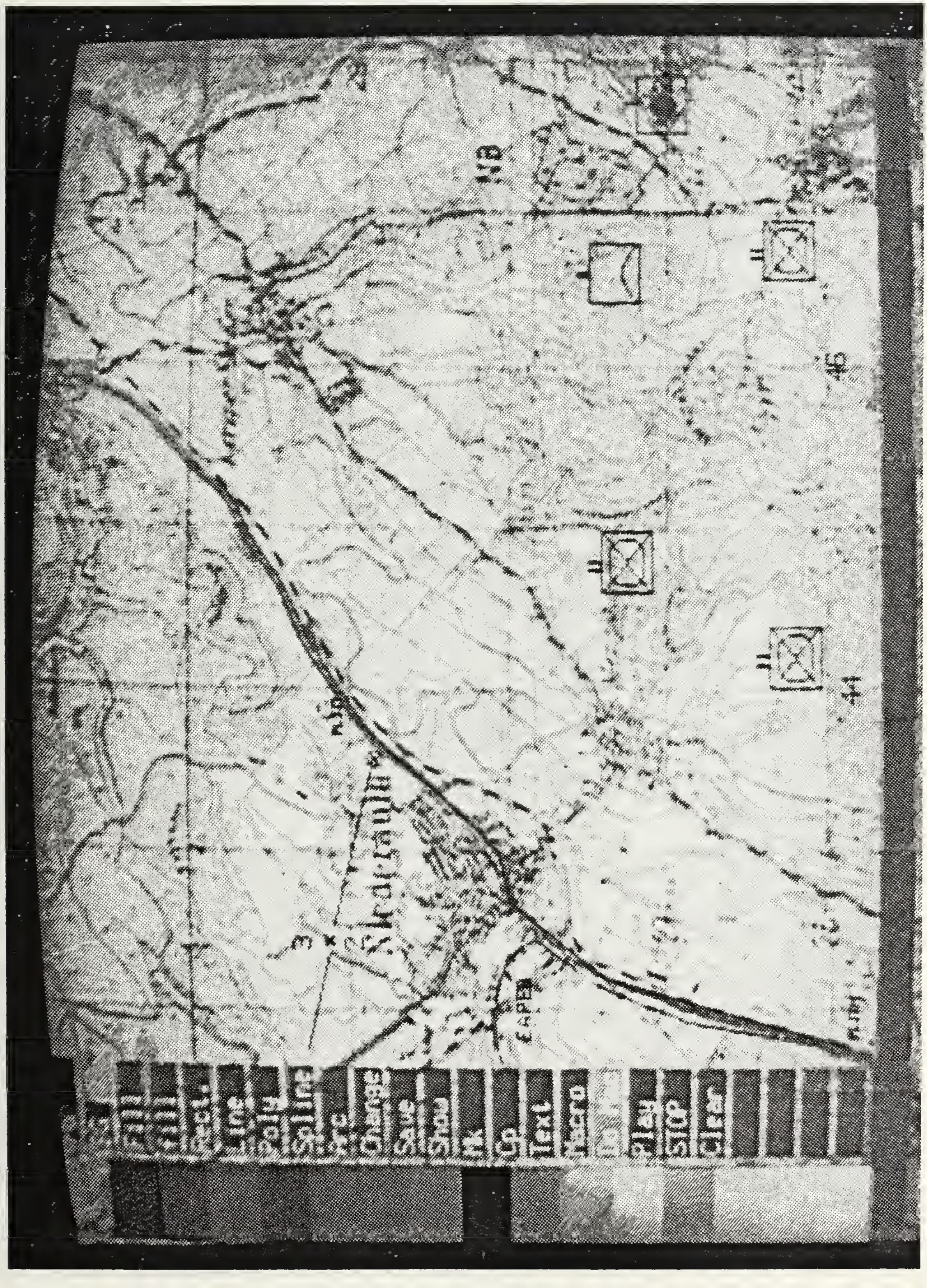


Figure E.10 Phase I Conventional Defensive Display (East Sector).

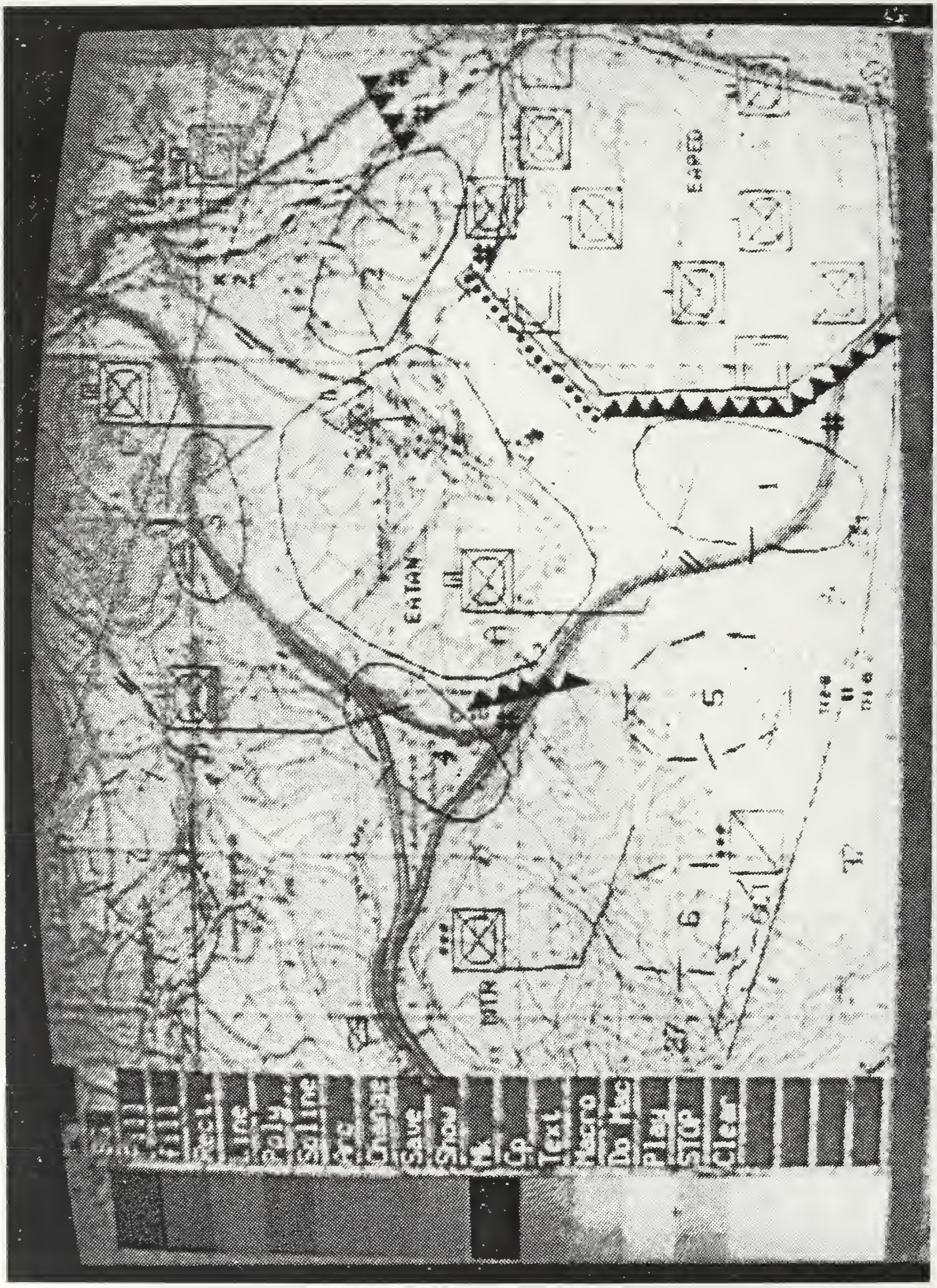


Figure E.11   Phase II Conventional Defensive Display

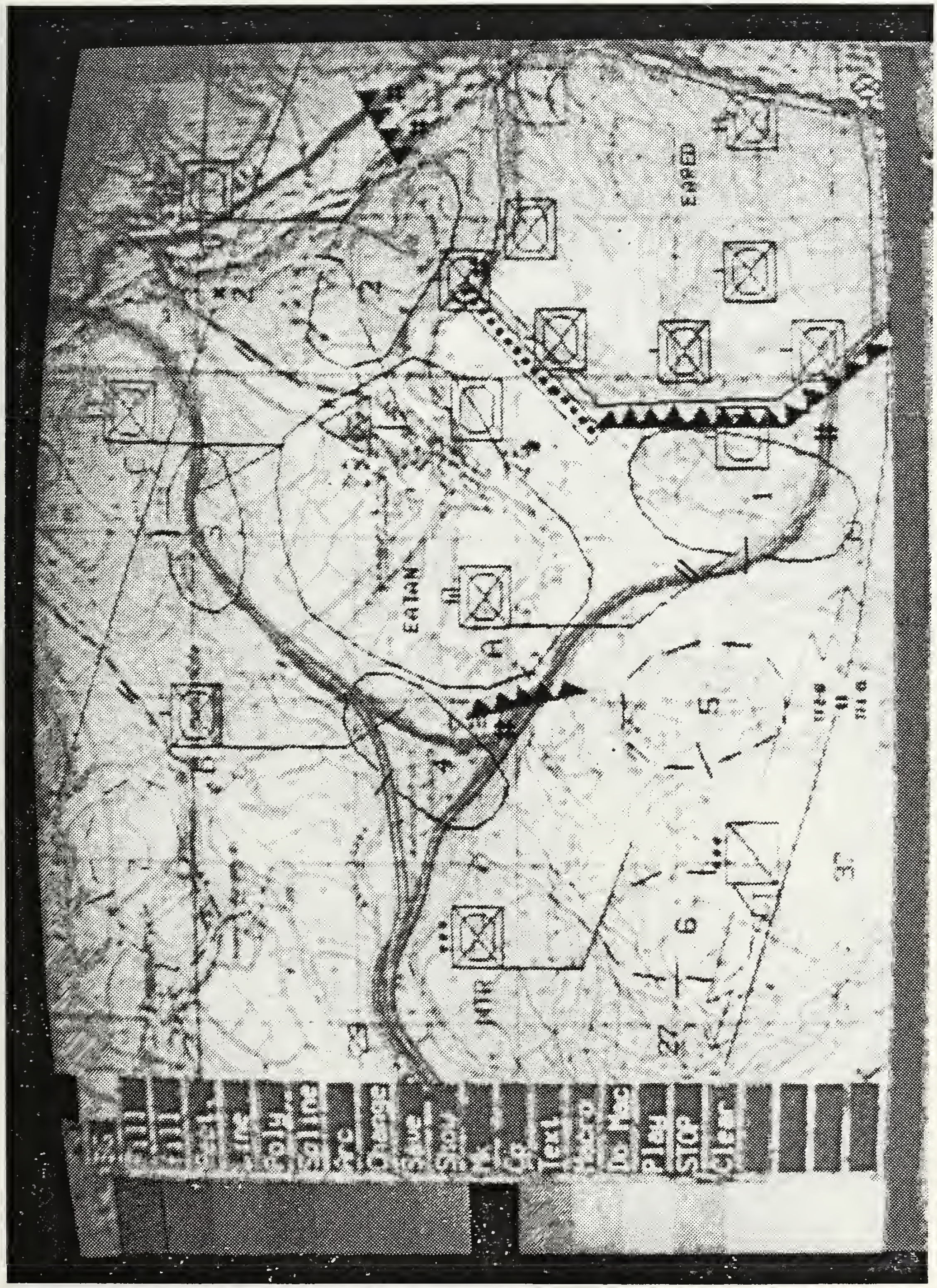


Figure E.12   Phase III Conventional Defensive Display

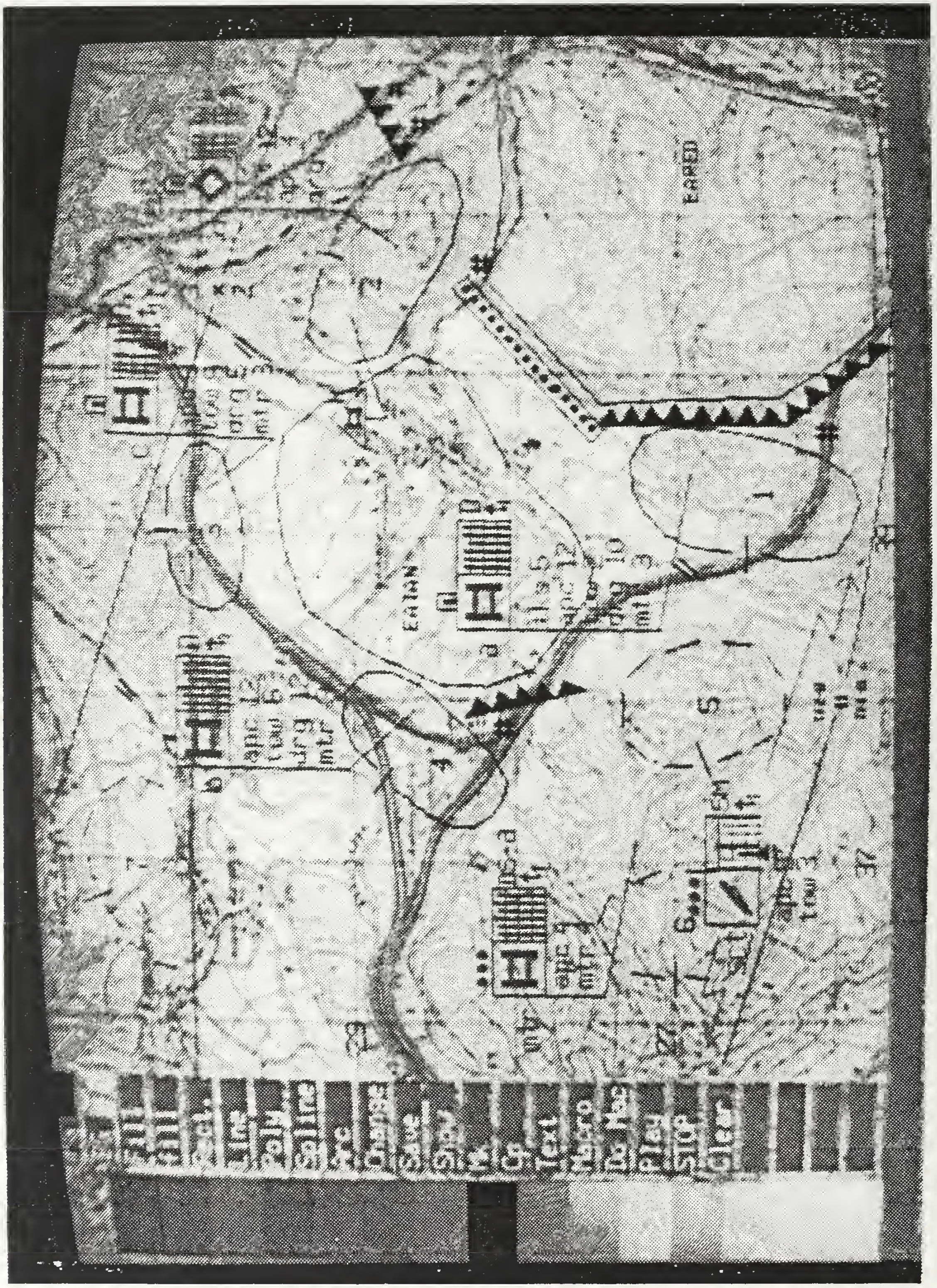


Figure E.13 Phase I Enhanced Defensive Display (West Sector).

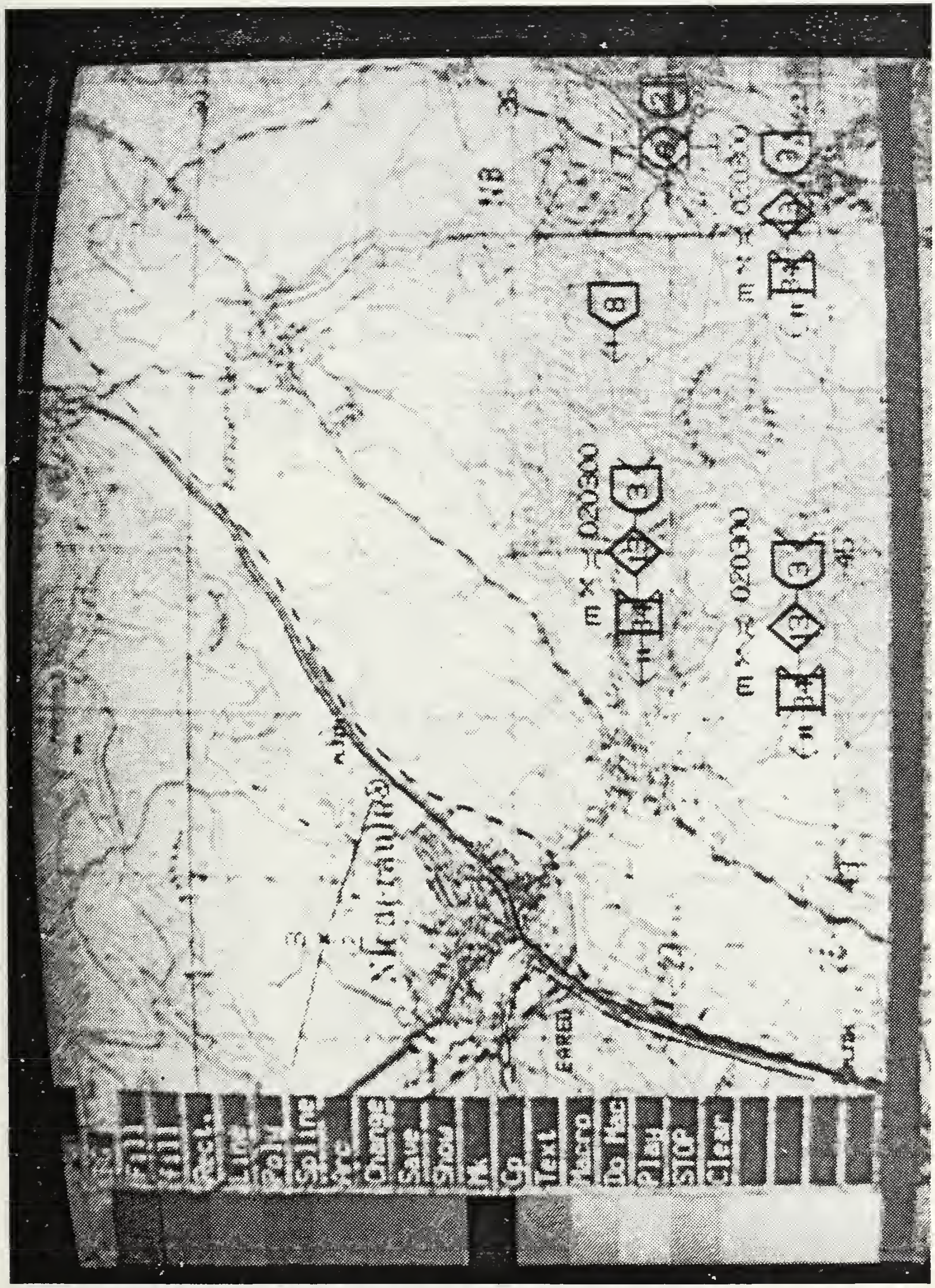


Figure E.14 Phase I Enhanced Defensive Display (East Sector).

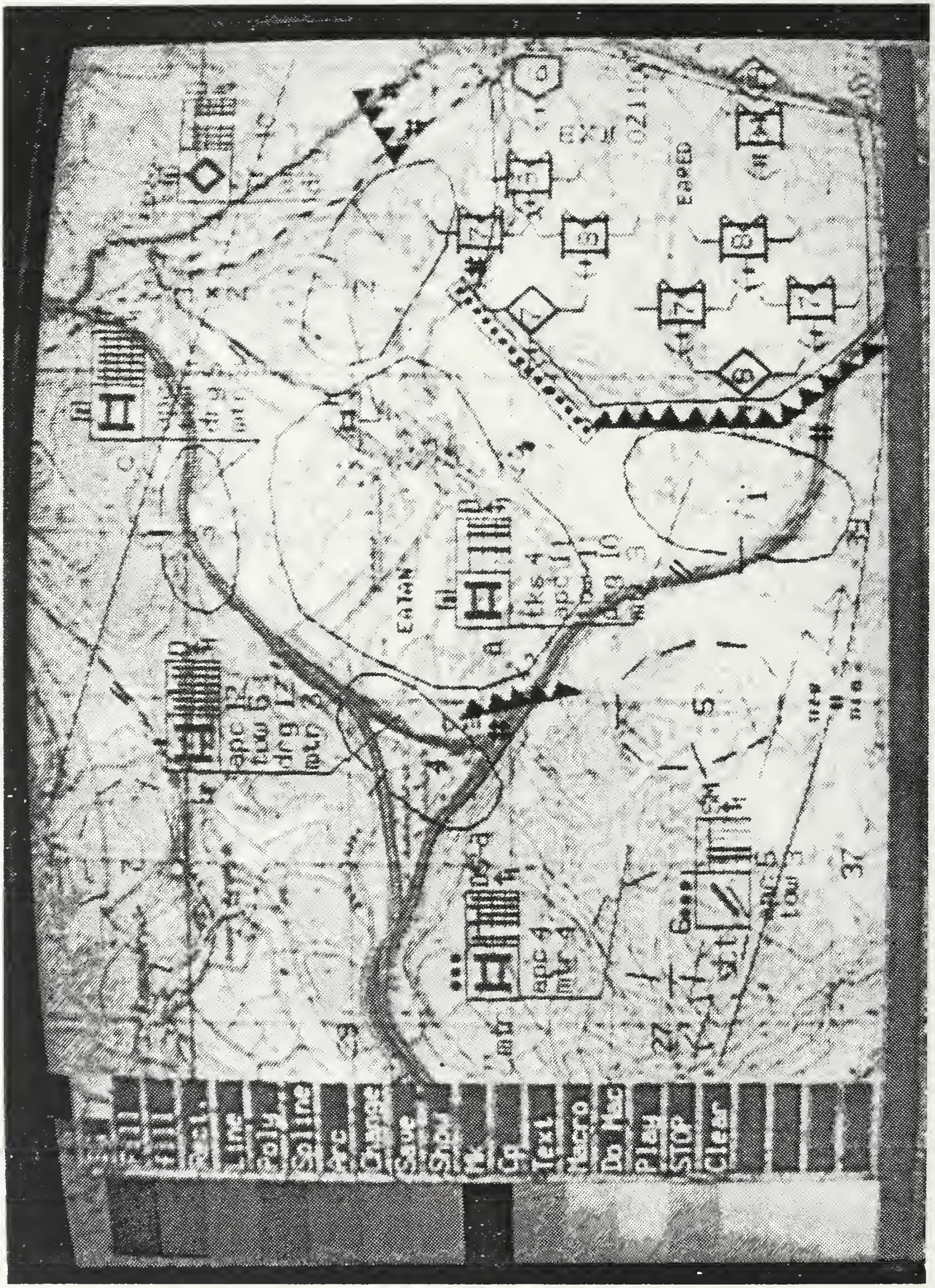


Figure E.15 Phase II Enhanced Defensive Display

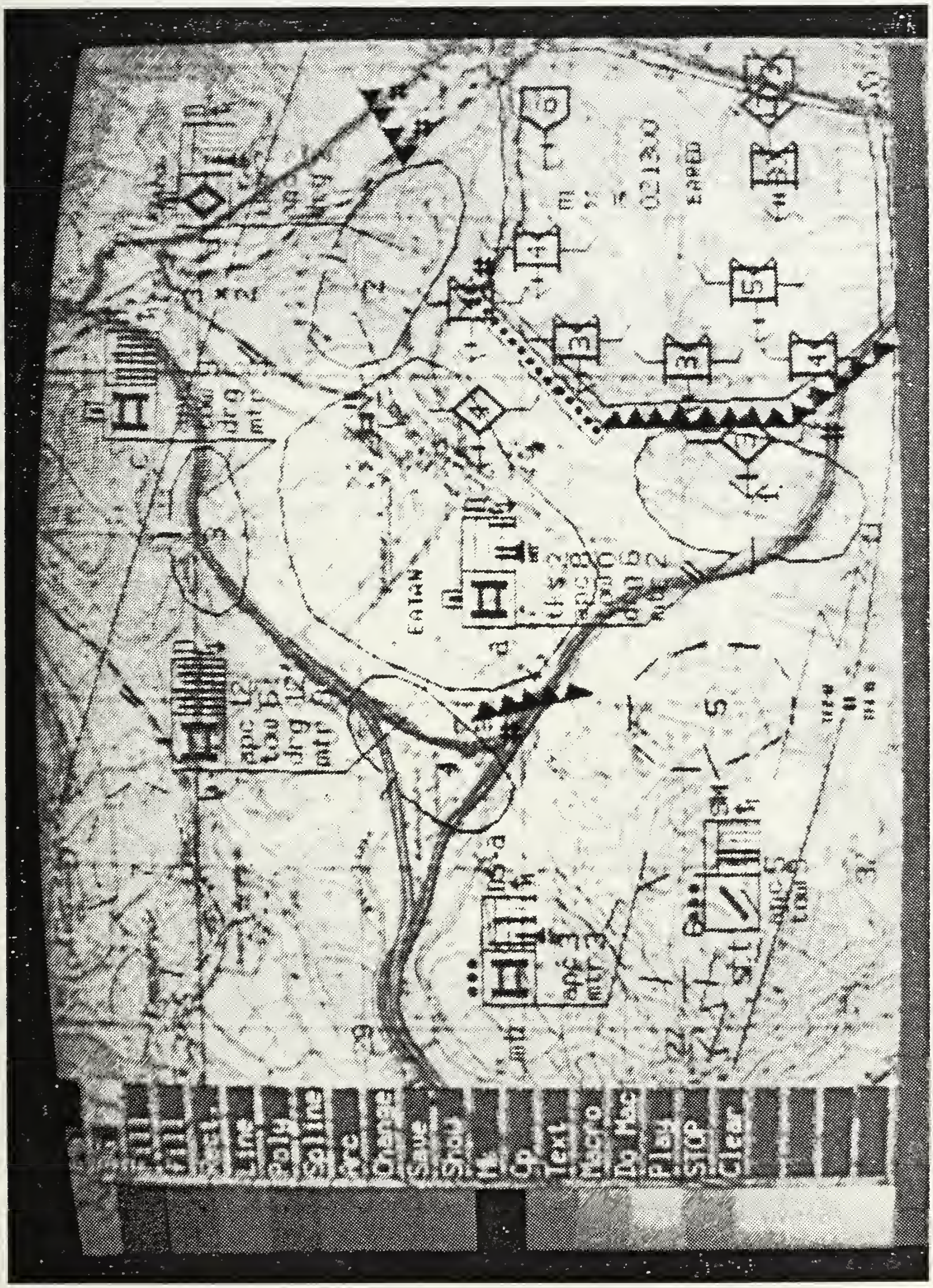


Figure E.16 Phase III Enhanced Defensive Display

APPENDIX F

QUESTIONS FOR THE OFFENSIVE TACTICAL SITUATION

Note - correct answer shown in parentheses following the question

Phase I Questions

How many mechanized infantry companies are within the battalion task force? (3)

How many tank companies are within the battalion task force? (1)

How many task force tactical communication links are working but are nonsecure? (1)

How many task force heavy mortars are operational? (4)

Which task force unit has the greatest number of TOW assets? (7)

1. Team A
2. Company B
3. Company C
4. Team D
5. Scout Platoon
6. Heavy Mortar Platoon
7. Antitank Platoon

Which task force unit has the greatest number of tank assets? (4)

1. Team A
2. Company B
3. Company C
4. Team D
5. Scout Platoon
6. Heavy Mortar Platoon
7. Antitank Platoon

Which, if any, task force unit has an emergency resupply request for fuel? (2)

1. Team A
2. Company B
3. Company C
4. Team D
5. Scout Platoon
6. Heavy Mortar Platoon
7. Antitank Platoon

Which task force unit has the greatest need for ammunition? (1)

1. Team A
2. Company B
3. Company C
4. Team D
5. Scout Platoon
6. Heavy Mortar Platoon
7. Antitank Platoon

Which task force unit has priority of fires from the heavy mortar platoon? (7)

1. Team A
2. Company B
3. Company C
4. Team D
5. Scout Platoon
6. Antitank Platoon
7. None. The mortars are in general support.

What is Team A's personnel, weapons and equipment status? (3)

1. Personnel > 50, Weapons > 75, Equipment > 50
2. Personnel > 75, Weapons > 50, Equipment > 50
3. Personnel > 75, Weapons > 75, Equipment > 75
4. Personnel > 50, Weapons > 50, Equipment > 75
5. Personnel > 50, Weapons > 50, Equipment > 50

How many enemy tanks have been identified in the vicinity of Objective A? (4)

How many motorized rifle companies are in defensive formations on Objectives A and B? (1)

Does the enemy motorized rifle battalion within the task force zone have a chemical capability? (1 = yes, 2 = no) (1)

How many enemy self-propelled artillery pieces have been reported in the task force zone of action? (6)

What is the current disposition and composition of the motorized rifle company located on Objective D? (1)

1. The MRC is in a defensive formation with 7 BMPs and is expected to delay.
2. The MRC is in a defensive formation with 10 BMPs and is expected to defend in place.
3. The MRC is in a defensive formation with 9 BMPs and is expected to delay.
4. The MRC is withdrawing from the objective with 9 BMPs.
5. The MRC is in an attack formation with 10 BMPs and 5 tanks.

Phase II Questions

How many operational tanks are with Team D? (9)

How many task force communication links are presently down? (1)

How many task force units have an ammunition status of 75 percent or below? (0)

How many enemy tanks have been identified in the vicinity of Objective E? (7)

How many enemy self-propelled artillery pieces are currently reported in the task force zone of action? (4)

How many task force companies or teams (Team A, Co B, Co C, Team D) have a personnel strength at or below 75 percent? (0)

How many task force heavy mortars are operational? (3)

How many motorized rifle companies are withdrawing? (1)

How many motorized rifle companies remain in defensive formations within the task force zone east of grid line 56? (3)

How many and what type of major weapons are currently operational with Company C? (2)

1. 9 APCs, 13 TOWs, 8 Dragons, 3 Mortars.
2. 9 APCs, 3 TOWs, 9 Dragons, 3 Mortars.
3. 7 APCs, 6 Dragons, 3 Mortars.
4. 10 APCs, 4 TOWs, 4 Dragons, 3 Mortars.
5. 9 APCs, 3 TOWs, 9 Dragons.

What is the composition of the enemy force east of grid line 56 within Team D's zone? (4)

1. 1 tank platoon, 2 motorized rifle companies, a motorized rifle platoon and an artillery battery.
2. 1 tank company, 2 motorized rifle companies and an artillery battery.
3. 1 tank company, 3 motorized rifle companies and an artillery battery.
4. 1 tank company, 2 motorized rifle companies, a motorized rifle platoon and an artillery battery.
5. 1 tank company, 1 motorized rifle company, a motorized rifle platoon and an artillery battery.

What is Team D's ammunition and POL status? (5)

1. Ammunition > 50, POL > 75
2. Ammunition > 50, POL > 50
3. Ammunition > 75, POL > 50
4. Ammunition > 25, POL > 50
5. Ammunition > 75, POL > 75

What are the actions of enemy forces on Objective F? (4)

1. A motorized rifle battalion is defending in place.
2. A motorized rifle company is in an attack formation moving west.
3. A motorized rifle company is withdrawing east.
4. A motorized rifle company is in a defensive formation and is expected to defend in place.
5. A motorized rifle company is in a defensive formation and is expected to delay.

What is the disposition of enemy forces on Objective D? (2)

1. A motorized rifle company is in a defensive formation with 7 BMPs and is expected to defend in place.
2. A motorized rifle company is in a defensive formation with 7 BMPs and is expected to delay.
3. A motorized rifle platoon is in a defensive formation with 4 BMPs and is expected to defend in place.
4. A motorized rifle company is in a defensive formation with 9 BMPs and is expected to delay.
5. A motorized rifle company is in a defensive formation with 9 BMPs and is expected to defend in place.

What is the most likely enemy course of action? (3)

1. Continue to delay.
2. Defend in place from current positions.
3. Delay until grid line 57 and then defend in place.
4. Counterattack through Objective E.
5. 2d echelon forces attack through 1st echelon.

What special capabilities does the opposing MRB have? (Note - do not consider the artillery) (1)

1. Engineer, chemical and bridging
2. Engineer, chemical, bridging and nuclear.
3. Chemical, bridging and nuclear.
4. Engineer, chemical and nuclear.
5. Engineer, bridging and nuclear.

Which task force company or team has the highest personnel status? (4)

1. Team A
2. Company B
3. Company C
4. Team D

What mission is currently assigned to the heavy mortar platoon? (2)

1. DS to Team D.
2. GS to the task force.
3. DS to Company B.
4. DS to Company C.
5. DS to Team A.

With which unit(s) does the task force not have secure communications? (3)

1. Team A
2. Team D
3. Company C
4. Company B and Company C
5. Scout Platoon
6. Heavy Mortar Platoon
7. Antitank Platoon

Phase III Questions

In view of the current situation, what action would you take to secure Objective E?

1. Have Team D hold its present position and direct Team A to pass through D and secure Objective E.
2. Hold Team D in place until Team A can come abreast. Then attack the objective with both teams on line.
3. Assuming permission has been granted to fire into 3d Brigade's zone, direct Team A to suppress by fire enemy elements on the high ground north of Objective E while Team D continues the attack to the objective.
4. Continue the attack exactly as planned by the OPORD.
5. Other.

In view of the current situation, what action would you take to secure Objective F?

1. Hold Company C in place until Company B can come on line and then attack the objective with the two companies on line.
2. Hold Company C in its present position and direct Company B to secure Objective F with Company C supporting by fire.
3. Redefine Company C's boundary to include the high ground between Objectives E and F. Direct Company C to secure that high ground and Company B to secure Objective F.
4. Continue the attack exactly as planned by the OPORD.
5. Other.

Based on your previous decisions, how would you alter the mission assigned to the Heavy Mortar Platoon?

6. DS Team A.
7. DS Team D
8. DS Company B.
9. DS Company C.
10. Remain GS.

APPENDIX G

QUESTIONS FOR THE DEFENSIVE TACTICAL SITUATION

Note - correct answer shown in parentheses following the question

Phase I Questions

How many mechanized infantry companies are within the battalion task force? (3)

How many tank companies are within the battalion task force? (1)

How many task force tactical communication links are working but are nonsecure? (0)

How many task force heavy mortars are operational? (4)

Which task force unit has the greatest number of TOW assets? (3)

1. Team A
2. Company B
3. Team C
4. Team D
5. Scout Platoon
6. Heavy Mortar Platoon

Which task force unit has the greatest number of tank assets? (4)

1. Team A
2. Company B
3. Team C
4. Team D
5. Scout Platoon
6. Heavy Mortar Platoon

Which, if any, task force unit has an emergency resupply request for fuel? (3)

1. Team A
2. Company B
3. Team C
4. Team D
5. Scout Platoon
6. Heavy Mortar Platoon

Which task force unit has the greatest need for ammunition? (5)

1. Team A
2. Company B
3. Team C
4. Team D
5. Scout Platoon
6. Heavy Mortar Platoon

Which task force unit has priority of fires from the heavy mortar platoon? (1)

1. Team A
2. Company B
3. Team C
4. Team D
5. Scout Platoon
6. None. The mortars are in general support.

What is Team A's personnel, weapons and equipment status? (3)

1. Personnel > 50, Weapons > 75, Equipment > 50
2. Personnel > 75, Weapons > 50, Equipment > 50
3. Personnel > 75, Weapons > 75, Equipment > 75
4. Personnel > 50, Weapons > 50, Equipment > 75
5. Personnel > 50, Weapons > 50, Equipment > 50

How many enemy tanks have been identified approaching the task force position? (39)

How many motorized rifle battalions are within 2 kilometers of the Fulda River? (2)

How many enemy motorized rifle battalions have a chemical capability? (3)

How many enemy self-propelled artillery pieces have been reported? (6)

What is the current disposition and composition of the first echelon motorized rifle battalions? (2)

1. The MRBs are in march column, each travelling west with 30 BMPs, 10 tanks and 3 BRDMs.
2. The MRBs are in march column, each travelling west with 34 BMPs, 13 tanks and 3 BRDMs.
3. The MRBs are in attack formations, each heading west with 30 BMPs, 10 tanks and 3 BRDMs.
4. The MRBs are in attack formations, each heading west with 34 BMPs, 13 tanks and 3 BRDMs.
5. The MRBs are stationary, each with 34 BMPs, 13 tanks and 3 BRDMs.

Phase II Questions

How many operational tanks are at Team A's battle position? (4)

How many task force communication links are presently down? (1)

How many task force units have an ammunition status of 75 percent or below? (2)

How many enemy tanks have been identified near the west edge of Engagement Area Red? (15)

How many enemy anti-air vehicles are currently reported? (6)

How many task force companies or teams (Team A, Co B, Team C, Team D) have a personnel strength at or below 75 percent? (1)

How many task force heavy mortars are operational? (4)

How many motorized rifle battalions are moving towards the task force zone of action? (3)

Of these motorized rifle battalions, how many have deployed into attack formations? (2)

How many and what type of major weapons are currently operational with Team C? (4)

1. 9 APCs, 10 TOWs, 4 Dragons, 3 Mortars.
2. 8 APCs, 4 TOWs, 4 Dragons, 3 Mortars.
3. 7 APCs, 8 TOWs, 13 Dragons, 3 Mortars.
4. 8 APCs, 9 TOWs, 5 Dragons, 3 Mortars.
5. 9 APCs, 13 TOWs, 12 Dragons, 3 Mortars.

What is the composition of the enemy force near Battle Position 2? (3)

1. An MRB composed of 1 tank platoon, 3 motorized rifle companies plus an air-defense company.
2. An MRB composed of 1 tank company, 2 motorized rifle companies plus an air-defense company.
3. An MRB composed of 1 tank company, 3 motorized rifle companies plus an air-defense company.
4. An MRB composed of 4 motorized rifle companies plus an air-defense company.
5. An MRB composed of 1 tank company and 4 motorized rifle companies.

What is Team D's ammunition and POL status? (3)

1. Ammunition > 50, POL > 75
2. Ammunition > 50, POL > 50
3. Ammunition > 75, POL > 50
4. Ammunition > 25, POL > 50
5. Ammunition > 75, POL > 75

What are the actions of enemy second echelon forces? (4)

1. A motorized rifle company in march column heading west with lead elements at the south-east corner of the task force zone.
2. A motorized rifle company in attack formation heading west with lead elements at the south-east corner of the task force zone.
3. A motorized rifle battalion in attack formation heading west with lead elements at the south-east corner of the task force zone.
4. A motorized rifle battalion in march column heading west with lead elements at the south-east corner of the task force zone.
5. A tank battalion in march column heading west with lead elements at the south-east corner of the task force zone.

What is the disposition of enemy first echelon forces? (1)

1. Two MRBs each with 1 tank company and 3 motorized rifle companies in attack formations.
2. One MRB with 1 tank company and 3 motorized rifle companies in attack formations.
3. Two MRBs each with 1 tank platoon and 3 motorized rifle companies in attack formations.
4. Two tank battalions each with 3 tank companies and 1 motorized rifle company in attack formations.
5. Two tank battalions each with 1 tank company and 3 motorized rifle companies in attack formations.

What is the most likely enemy course of action? (5)

1. Conduct a breakthrough along the avenue of approach through Engagement Area Tan and Company B's position.
2. Attack across a wide frontage to destroy the entire task force.
3. The 1st echelon will hold present positions and allow the 2d echelon to attack through to the west.
4. Hold present positions and await reinforcements.
5. Conduct a breakthrough alone the avenue of approach through Team A's position to the west.

What special capabilities do the enemy motorized rifle battalions in the 1st echelon have? (Note - do not consider the artillery) (1)

1. Engineer, chemical and bridging
2. Engineer, chemical, bridging and nuclear.
3. Chemical, bridging and nuclear.
4. Engineer, chemical and nuclear.
5. Engineer, bridging and nuclear.

Which task force company or team has the lowest personnel status? (1)

1. Team A
2. Company B
3. Team C
4. Team D

What mission is currently assigned to the heavy mortar platoon? (5)

1. GS to the task force.
2. DS to Team D.
3. DS to Company B.
4. DS to Team C.
5. DS to Team A.

With which unit(s) does the task force not have secure communications? (3)

1. Team A
2. Team A and Team D
3. Team C
4. Company B and Team C
5. Scout Platoon
6. Heavy Mortar Platoon

Phase III Questions

Enemy forces have penetrated Battle Position 1. What actions would you take to contain the penetration?

1. Direct Team A to displace to BP 5 (where a cache of ammunition has been staged), occupy and hold that position.
2. Direct Team A to displace to BP 5 and reinforce the team with 1 platoon from Company B.
3. Direct Company B to counterattack enemy elements near BP 1 through Team A's position.
4. Continue the mission with no change from the OPORD.
5. Other.

In view of the current situation, what action would you take regarding the northern flank of your zone?

1. Direct Team D to displace to BP 7 (where a cache of ammunition has been staged), occupy and hold that position.
2. Reinforce Team D on BP 2 with one platoon from Team C.
3. Reinforce Team D on BP 2 with one TOW section from Team C and one from Company B.
4. Continue the mission with no change from the OPORD.
5. Other.

Based on your previous decisions, how would you alter the mission assigned to the Heavy Mortar Platoon?

6. DS Team A.
7. DS Team D
8. DS Company B.
9. DS Team C.
10. Place in GS.

APPENDIX H

FORTRAN PROGRAM

```
C
C      *** PURPOSE ***
C      THIS PROGRAM PRESENTS A SERIES OF TACTICAL
C      QUESTIONS TO THE SUBJECT AND RECORDS THE
C      NECESSARY DATA FOR TESTING OF THE SYMBOLOGY
C      EXPERIMENT'S HYPOTHESES.
C
       PROGRAM DISPLAY_SYMEXP
C
C      *** VARIABLE DEFINITIONS ***
C      MAX_SUBJS = MAX NUMBER OF SUBJECTS
C      MAX_QUEST = MAX NUMBER OF QUESTIONS
C      LOG_UNIT  = LOGICAL UNIT NUMBER
C      MAXTSN    = MAX NUMBER OF TACTICAL SITUATIONS
C      ANSWER    = ANSWER
C      LAST1     = TAC SIT #1 CURRENT SUBJECT NUMBER
C      LAST2     = TAC SIT #2 CURRENT SUBJECT NUMBER
C      TS1ATT    = TAC SIT #1 ARRAY OF NUMBER OF ATTEMPTS
C                  TO CORRECT RESPONSE FOR EACH PHASE II
C                  QUESTION
C      TS2ATT    = TAC SIT #2 ARRAY OF NUMBER OF ATTEMPTS
C                  TO CORRECT RESPONSE FOR EACH PHASE II
C                  QUESTION
C      TS1TIM    = TAC SIT #1 ARRAY OF TIME TO CORRECT
C                  RESPONSE FOR EACH PHASE II QUESTION
C                  AND TIME TO RESPONSE FOR EACH PHASE III
C                  QUESTION
C      TS2TIM    = TAC SIT #2 ARRAY OF TIME TO CORRECT
C                  RESPONSE FOR EACH PHASE II QUESTION
C                  AND TIME TO RESPONSE FOR EACH PHASE III
C                  QUESTION
C      TACS_COUNT= TACTICAL SITUATION COUNT
C      TACSNUM   = TACTICAL SITUATION NUMBER
C      CORR_ANS  = CORRECT ANSWER
C      QUEST_NUM = QUESTION NUMBER
C      SUBJ_ANS  = SUBJECT'S ANSWER
C
       COMMON /A/ TS1TIM,TS2TIM
       COMMON /B/ TS1ATT,TS2ATT
       COMMON /C/ LAST1,LAST2
       COMMON /D/ MAX_SUBJS,MAX_QUEST,LOG_UNIT
C
       REAL TS1TIM (30,15), TS2TIM (30,15)
       INTEGER TS1ATT (30,15), TS2ATT (30,15)
       INTEGER SUBJ_NUM, MAX_SUBJS, MAX_QUEST
       INTEGER QUEST_NUM, CORR_ANS
       INTEGER LAST1, LAST2
       INTEGER TACSNUM, MAXTSN, TACS_COUNT
       CHARACTER*1 ANSWER
C
       DATA MAX_SUBJS /15/
       DATA MAX_QUEST /30/
       DATA LOG_UNIT  /4/
       DATA MAXTSN    /2/
C
C      *** RESET DATA FILES IF DESIRED ***
C
       CALL CLR_SCRN
       TYPE *, 'DO YOU WANT TO SET ALL DATA ARRAYS AND FILES'
```

```
         TYPE *,  'TO ZERO (O) ?'
         TYPE *,  'ALL DATA WILL BE DESTROYED IF YOU DO. '
         TYPE *,  ' '
         TYPE *,  'TYPE CHARACTER (Y OR N)'
C
         CALL READ_ANS (ANSWER)
C
         IF( ANSWER.EQ.'Y') THEN
            TYPE *,  ' '
            TYPE *,  'ARE YOU SURE?'
            TYPE *,  ' '
            TYPE *,  'TYPE CHARACTER (Y OR N)'
            CALL READ_ANS (ANSWER)
            IF (ANSWER.EQ.'N') THEN
               GO TO 40
            END IF
            LAST1 = 0
            LAST2 = 0
C
            DO I = 1,MAX_QUEST
                DO J = 1,MAX_SUBJS
                    TS1TIM(I,J) = 0.0
                    TS1ATT(I,J) = 0
                    TS2TIM(I,J) = 0.0
                    TS2ATT(I,J) = 0
                END DO
             END DO
C
             CALL OUT_DATA
C
         END IF
C
      40 TYPE *,  ' '
C
C        *** READ IN DATA FILES ***
C
         CALL READ_DATA
C
C        *** SET TACTICAL SITUATION COUNT ***
C
         TACS_COUNT = 1
C
      50 CALL CLR_SCRN
C
C        *** END EXPERIMENT IF SUBJECT HAS COMPLETED BOTH ***
C            SITUATIONS
C
         IF (TACS_COUNT.GT.MAXTSN) THEN
            TYPE *,  '********** EXPERIMENT IS OVER ***********'
            TYPE *,  ' '
            TYPE *,  '****** THANK YOU FOR PARTICIPATING *******'
            TYPE *,  ' '
            TYPE *,  ' '
C
C        *** EXIT THE PROGRAM OR CONTINUE THE EXPERIMENT ***
C
            TYPE *,  'DO YOU WANT TO STOP THE EXPERIMENT?'
            TYPE *,  'TYPE CHARACTER ( Y OR N )'
C
            CALL READ_ANS (ANSWER)
C
```

```
         IF (ANSWER.EQ.'Y') THEN
            TYPE *, 'PROGRAM IS OVER'
            STOP
         END IF
C
         TYPE *, 'NEXT SUBJECT PLEASE'
         TYPE *, ' '
         TYPE *, 'TYPE: "C" WHEN READY'
C
         TACS_COUNT = 1
C
         PAUSE
C
      END IF
C
C     *** DISPLAY EXPERIMENT DESCRIPTION IF SUBJECT'S FIRST TRIAL ***
C
      IF (TACS_COUNT.EQ.1) THEN
C
      TYPE *,'   The experiment you are about to undergo involves an'
      TYPE *,'offensive and a defensive tactical situation. One'
      TYPE *,'situation will be presented using conventional symbology'
      TYPE *,'and the other using enhanced symbology.'
      TYPE *,'   Each situation is divided into three phases. Phases I'
      TYPE *,'and II ask a series of questions requiring you to'
      TYPE *,'extract, from the situation display and/or hard copy'
      TYPE *,'messages, tactical information you would require to make'
      TYPE *,'a decision.  Phase III asks questions that require you'
      TYPE *,'to make decisions regarding the tactical employment of'
      TYPE *,'your forces.'
      TYPE *, ' '
      TYPE *, 'TYPE: "C" TO CONTINUE'
C
      PAUSE
      TYPE *,'   Phase I begins prior to enemy contact and is designed'
      TYPE *,'to orient you to the situation. Some of the questions'
      TYPE *,'expect a numerical answer and the others allow you to'
      TYPE *,'select the best answer among a list of choices. In'
      TYPE *,'either case you must get the correct answer before'
      TYPE *,'proceeding. Your performance is not recorded so take'
      TYPE *,'your time to become familiar with the situation and'
      TYPE *,'symbology.'
      TYPE *,'   Phase II begins a few hours later in the situation'
      TYPE *,'after enemy contact has begun. The questions are'
      TYPE *,'similar to those of Phase I but your performance is now'
      TYPE *,'measured. Answer the questions as accurately as possible'
      TYPE *,'in as little time as possible.'
      TYPE *,'   Phase III begins well into the situation. For each'
      TYPE *,'question, you will be given several courses of action'
      TYPE *,'regarding the tactical employment of your units. Select'
      TYPE *,'the best course of action based on the situation as it'
      TYPE *,'has developed. Since there are no "correct" answers, you'
      TYPE *,'will be asked to defend your choices.'
      TYPE *, ' '
      TYPE *, 'TYPE: "C" TO CONTINUE'
C
      PAUSE
      END IF
C
C     *** SELECT TACTICAL SITUATION ***
C
```

```
      TYPE *, 'ENTER DESIRED TACTICAL SITUATION NUMBER'
      TYPE *, 'TYPE INTEGER 1 TO', MAXTSN
C
      ACCEPT *, TACSNUM
C
      DO WHILE (TACSNUM.LT.1.OR.TACSNUM.GT.MAXTSN)
          TYPE *, 'INVALID RESPONSE....TRY AGAIN.'
          TYPE *, 'TYPE INTEGER 1 TO', MAXTSN
          ACCEPT *, TACSNUM
      END DO
C
      IF (TACS_COUNT.LE.MAXTSN) THEN
         TACS_COUNT = TACS_COUNT + 1
         IF (TACSNUM.EQ.2) THEN
             GO TO 200
         END IF
C
      ELSE
C
         GO TO 50
C
      END IF
C
C
  100 CONTINUE
C
C     *** START TACTICAL SITUATION #1 (OFFENSE) ***
C
      CALL CLR_SCRN
C
      CALL SETUP_TACS ( 1, LAST1, MAX_SUBJS )
C
      TYPE *,' '
      TYPE *,'This is an offensive tactical situation in which your'
      TYPE *,'battalion task force must operate against an enemy'
      TYPE *,'motorized rifle battalion.  The experiment monitor'
      TYPE *,'will now brief the operation.  See OPORD 1-85 '
      TYPE *, ' '
      TYPE *, 'TYPE: "C" TO CONTINUE'
C
      PAUSE
C
C     *** PHASE I GENERAL SITUATION ***
C
      CALL CLR_SCRN
      TYPE *,'This is Phase I (Offense).  Ask the experiment monitor'
      TYPE *,'to display the Phase I situation.'
      TYPE *, ' '
      TYPE *,'The time is H-15 minutes (020600).  Preparatory fires are'
      TYPE *,'underway, all units are enroute to the Line of Departure'
      TYPE *,'and as yet undetected.  The Scout Platoon has secured the'
      TYPE *,'bridges and fording sites.  An updated Intelligence'
      TYPE *,'Summary has been received from Brigade.'
      TYPE *, ' '
      TYPE *,'Read the Phase I message traffic.  Note this'
      TYPE *,'traffic was received since the OPORD was issued and'
      TYPE *,'prior to Phase I.'
      TYPE *, ' '
      TYPE *,'TYPE: "C" TO BEGIN PHASE I QUESTIONS. BE SURE TO SELECT'
      TYPE *,'THE BEST ANSWER FOR MULTIPLE CHOICE QUESTIONS.'
      TYPE *, ' '
```

```
C
      PAUSE
C
C     *** PHASE I QUESTIONS ***
C
      CALL CLR_SCRN
      CORR_ANS = 3
      TYPE *,'How many mechanized infantry companies are within'
      TYPE *,'the battalion task force?'
      CALL CHK_ANS ( CORR_ANS )
C
      CALL CLR_SCRN
      CORR_ANS = 1
      TYPE *,'How many tank companies are within the battalion'
      TYPE *,'task force?'
      CALL CHK_ANS ( CORR_ANS )
C
      CALL CLR_SCRN
      CORR_ANS = 1
      TYPE *,'How many task force tactical communication links'
      TYPE *,'are working but are nonsecure?'
      CALL CHK_ANS ( CORR_ANS )
C
      CALL CLR_SCRN
      CORR_ANS = 4
      TYPE *,'How many task force heavy mortars are operational?'
      CALL CHK_ANS ( CORR_ANS )
C
      CALL CLR_SCRN
      CORR_ANS = 7
      TYPE *,'Which task force unit has the greatest number of'
      TYPE *,'TOW assets?'
      TYPE *,' '
      TYPE *,'  1.  Team A'
      TYPE *,'  2.  Company B'
      TYPE *,'  3.  Company C'
      TYPE *,'  4.  Team D'
      TYPE *,'  5.  Scout Platoon'
      TYPE *,'  6.  Heavy Mortar Platoon'
      TYPE *,'  7.  Antitank Platoon'
      CALL CHK_ANS ( CORR_ANS )
C
      CALL CLR_SCRN
      CORR_ANS = 4
      TYPE *,'Which task force unit has the greatest number of'
      TYPE *,'tank assets?'
      TYPE *,' '
      TYPE *,'  1.  Team A'
      TYPE *,'  2.  Company B'
      TYPE *,'  3.  Company C'
      TYPE *,'  4.  Team D'
      TYPE *,'  5.  Scout Platoon'
      TYPE *,'  6.  Heavy Mortar Platoon'
      TYPE *,'  7.  Antitank Platoon'
      CALL CHK_ANS ( CORR_ANS )
C
      CALL CLR_SCRN
      CORR_ANS = 2
      TYPE *,'Which, if any, task force unit has an emergency'
      TYPE *,'resupply request for fuel?'
      TYPE *,' '
      TYPE *,'  1.  Team A'
      TYPE *,'  2.  Company B'
      TYPE *,'  3.  Company C'
      TYPE *,'  4.  Team D'
      TYPE *,'  5.  Scout Platoon'
      TYPE *,'  6.  Heavy Mortar Platoon'
      TYPE *,'  7.  Antitank Platoon'
      CALL CHK_ANS ( CORR_ANS )
C
      CALL CLR_SCRN
      CORR_ANS = 1
      TYPE *,'Which task force unit has the greatest need for'
      TYPE *,'ammunition?'
      TYPE *,' '
      TYPE *,'  1.  Team A'
      TYPE *,'  2.  Company B'
      TYPE *,'  3.  Company C'
      TYPE *,'  4.  Team D'
      TYPE *,'  5.  Scout Platoon'
      TYPE *,'  6.  Heavy Mortar Platoon'
      TYPE *,'  7.  Antitank Platoon'
      CALL CHK_ANS ( CORR_ANS )
C
      CALL CLR_SCRN
      CORR_ANS = 7
      TYPE *,'Which task force unit has priority of fires from'
      TYPE *,'the heavy mortar platoon?'
      TYPE *,' '
      TYPE *,'  1.  Team A'
      TYPE *,'  2.  Company B'
      TYPE *,'  3.  Company C'
      TYPE *,'  4.  Team D'
      TYPE *,'  5.  Scout Platoon'
      TYPE *,'  6.  Antitank Platoon'
      TYPE *,'  7.  None.  The mortars are in general support'
      CALL CHK_ANS ( CORR_ANS )
C
      CALL CLR_SCRN
      CORR_ANS = 3
      TYPE *,'What is Team A''s personnel, weapons and equipment'
      TYPE *,'status?'
      TYPE *,' '
      TYPE *,'  1.  Personnel > 50, Weapons > 75, Equipment > 50'
      TYPE *,'  2.  Personnel > 75, Weapons > 50, Equipment > 50'
      TYPE *,'  3.  Personnel > 75, Weapons > 75, Equipment > 75'
      TYPE *,'  4.  Personnel > 50, Weapons > 50, Equipment > 75'
      TYPE *,'  5.  Personnel > 50, Weapons > 50, Equipment > 50'
      CALL CHK_ANS ( CORR_ANS )
C
      CALL CLR_SCRN
      CORR_ANS = 4
      TYPE *,'How many enemy tanks have been identified in the'
      TYPE *,'vicinity of Objective A?'
      CALL CHK_ANS ( CORR_ANS )
C
      CALL CLR_SCRN
      CORR_ANS = 1
      TYPE *,'How many motorized rifle companies are in defensive'
      TYPE *,'formations on Objectives A and B?'
      CALL CHK_ANS ( CORR_ANS )
C
```

```
      CALL CLR_SCRN
      TYPE *,'The following questions require the map frame directly'
      TYPE *,'east of the one you see.  Ask the experiment monitor to'
      TYPE *,'display the next frame and overlay before you proceed.'
      TYPE *,  ' '
      TYPE *,  'TYPE: "C" TO CONTINUE'
C
      PAUSE
C
      CALL CLR_SCRN
      CORR_ANS = 1
      TYPE *,'Does the enemy motorized rifle battalion within the'
      TYPE *,'task force zone have a chemical capability?'
      TYPE *,'(1 = yes, 2 = no)'
      CALL CHK_ANS ( CORR_ANS )
C
      CALL CLR_SCRN
      CORR_ANS = 6
      TYPE *,'How many enemy self-propelled artillery pieces'
      TYPE *,'have been reported in the task force zone of action?'
      CALL CHK_ANS ( CORR_ANS )
C
      CALL CLR_SCRN
      CORR_ANS = 1
      TYPE *,'What is the current disposition and composition'
      TYPE *,'of the motorized rifle company located on Objective D?'
      TYPE *,' '
      TYPE *,'  1. The MRC is in a defensive formation with 7 BMPs'
      TYPE *,'     and is expected to delay.'
      TYPE *,'  2. The MRC is in a defensive formation with 10 BMPs'
      TYPE *,'     and is expected to defend in place.'
      TYPE *,'  3. The MRC is in a defensive formation with 9 BMPs'
      TYPE *,'     and is expected to delay.'
      TYPE *,'  4. The MRC is withdrawing from the objective with'
      TYPE *,'     9 BMPs.'
      TYPE *,'  5. The MRC is in an attack formation with 10 BMPs'
      TYPE *,'     and 5 tanks.'
      CALL CHK_ANS ( CORR_ANS )
C
C     *** PHASE II GENERAL SITUATION ***
C
      CALL CLR_SCRN
      TYPE *,  'END OF PHASE I (OFFENSE)'
      TYPE *,  ' '
      TYPE *,'This is Phase II (Offense). Ask the experiment monitor'
      TYPE *,'to display the Phase II situation.'
      TYPE *,  ' '
      TYPE *,'The time is H+2 hours (020815). The enemy has withdrawn'
      TYPE *,'from objectives A and B with forward elements delaying.'
      TYPE *,'The task force has secured these objectives. Both sides'
      TYPE *,'have suffered casualties and the task force is still in'
      TYPE *,'contact. The Scout Platoon is now screening the north'
      TYPE *,'flank.'
      TYPE *,  ' '
      TYPE *,'Read the Phase II message traffic. This traffic was'
      TYPE *,'received after the start of Phase I and'
      TYPE *,'prior to Phase II.'
      TYPE *,' '
      TYPE *,  'TYPE: "C" WHEN READY FOR PHASE II QUESTIONS. BE SURE TO'
      TYPE *,'SELECT THE BEST ANSWER FOR MULTIPLE CHOICE QUESTIONS AND'
      TYPE *,'ANSWER AS ACCURATELY AS POSSIBLE, IN AS LITTLE TIME AS'
      TYPE *, 'POSSIBLE. '
      TYPE *,  ' '
C
      PAUSE
C
C     *** PHASE II QUESTIONS ***
C
      CALL CLR_SCRN
      CORR_ANS = 9
      QUEST_NUM = 1
      TYPE *, 'How many operational tanks are with Team D?'
      CALL TIME_RESP ( LAST1, TS1TIM, TS1ATT,
     1                 CORR_ANS, QUEST_NUM )
C
      CALL CLR_SCRN
      CORR_ANS = 1
      QUEST_NUM = 2
      TYPE *, 'How many task force communication links are presently'
      TYPE *, 'down?'
      CALL TIME_RESP ( LAST1, TS1TIM, TS1ATT,
     1                 CORR_ANS, QUEST_NUM )
C
      CALL CLR_SCRN
      CORR_ANS = 0
      QUEST_NUM = 3
      TYPE *, 'How many task force units have an ammunition status of'
      TYPE *, '75 percent or below?'
      CALL TIME_RESP ( LAST1, TS1TIM, TS1ATT,
     1                 CORR_ANS, QUEST_NUM )
C
      CALL CLR_SCRN
      CORR_ANS = 7
      QUEST_NUM = 4
      TYPE *, 'How many enemy tanks have been identified in'
      TYPE *, 'the vicinity of Objective E?'
      CALL TIME_RESP ( LAST1, TS1TIM, TS1ATT,
     1                 CORR_ANS, QUEST_NUM )
C
      CALL CLR_SCRN
      CORR_ANS = 4
      QUEST_NUM = 5
      TYPE *, 'How many enemy self-propelled artillery pieces are'
      TYPE *, 'currently reported in the task force zone of action?'
      CALL TIME_RESP ( LAST1, TS1TIM, TS1ATT,
     1                 CORR_ANS, QUEST_NUM )
C
      CALL CLR_SCRN
      CORR_ANS = 0
      QUEST_NUM = 6
      TYPE *, 'How many task force companies or teams'
      TYPE *, '(Team A, Co B, Co C, Team D) have a'
      TYPE *, 'personnel strength at or below 75 percent?'
      CALL TIME_RESP ( LAST1, TS1TIM, TS1ATT,
     1                 CORR_ANS, QUEST_NUM )
C
      CALL CLR_SCRN
      CORR_ANS = 3
      QUEST_NUM = 7
      TYPE *, 'How many task force heavy mortars are operational?'
      CALL TIME_RESP ( LAST1, TS1TIM, TS1ATT,
     1                 CORR_ANS, QUEST_NUM )
```

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C
      CALL CLR_SCRN
      CORR_ANS = 1
      QUEST_NUM = 8
      TYPE *,'How many motorized rifle companies are withdrawing?'
      CALL TIME_RESP ( LAST1, TS1TIM, TS1ATT,
     1                 CORR_ANS, QUEST_NUM )
C
      CALL CLR_SCRN
      CORR_ANS = 3
      QUEST_NUM = 9
      TYPE *,'How many motorized rifle companies remain in'
      TYPE *,'defensive formations within the task force zone'
      TYPE *,'east of grid line 56?'
      CALL TIME_RESP ( LAST1, TS1TIM, TS1ATT,
     1                 CORR_ANS, QUEST_NUM )
C
      CALL CLR_SCRN
      CORR_ANS = 2
      QUEST_NUM = 10
      TYPE *,'How many and what type of major weapons are'
      TYPE *,'currently operational with Company C?'
      TYPE *,' '
      TYPE *,'  1. 9 APCs, 13 TOWs, 8 Dragons, 3 Mortars.'
      TYPE *,'  2. 9 APCs, 3 TOWs, 9 Dragons, 3 Mortars.'
      TYPE *,'  3. 7 APCs, 6 Dragons, 3 Mortars.'
      TYPE *,'  4. 10 APCs, 4 TOWs, 4 Dragons, 3 Mortars.'
      TYPE *,'  5. 9 APCs, 3 TOWs, 9 Dragons.'
      CALL TIME_RESP ( LAST1, TS1TIM, TS1ATT,
     1                 CORR_ANS, QUEST_NUM )
C
      CALL CLR_SCRN
      CORR_ANS = 4
      QUEST_NUM = 11
      TYPE *,'What is the composition of the enemy force east'
      TYPE *,'of grid line 56 within Team D''s zone?'
      TYPE *,' '
      TYPE *,'  1. 1 tank platoon, 2 motorized rifle companies,'
      TYPE *,'     a motorized rifle platoon and an artillery battery.'
      TYPE *,'  2. 1 tank company, 2 motorized rifle companies,'
      TYPE *,'     and an artillery battery.'
      TYPE *,'  3. 1 tank company, 3 motorized rifle companies,'
      TYPE *,'     and an artillery battery.'
      TYPE *,'  4. 1 tank company, 2 motorized rifle companies,'
      TYPE *,'     a motorized rifle platoon and an artillery battery.'
      TYPE *,'  5. 1 tank company, 1 motorized rifle company,'
      TYPE *,'     a motorized rifle platoon and an artillery battery.'
      CALL TIME_RESP ( LAST1, TS1TIM, TS1ATT,
     1                 CORR_ANS, QUEST_NUM )
C
      CALL CLR_SCRN
      CORR_ANS = 5
      QUEST_NUM = 12
      TYPE *,'What is Team D''s ammunition and POL status?'
      TYPE *,' '
      TYPE *,'  1. Ammunition > 50, POL > 75'
      TYPE *,'  2. Ammunition > 50, POL > 50'
      TYPE *,'  3. Ammunition > 75, POL > 50'
      TYPE *,'  4. Ammunition > 25, POL > 50'
      TYPE *,'  5. Ammunition > 75, POL > 75'
      CALL TIME_RESP ( LAST1, TS1TIM, TS1ATT,
     1                    CORR_ANS, QUEST_NUM )
C
      CALL CLR_SCRN
      CORR_ANS = 4
      QUEST_NUM = 13
      TYPE *,'What are the actions of enemy forces on Objective F?'
      TYPE *,' '
      TYPE *,'  1.  A motorized rifle battalion is defending in place. '
      TYPE *,'  2.  A motorized rifle company is in an attack formation'
      TYPE *,'      moving west. '
      TYPE *,'  3.  A motorized rifle company is withdrawing east. '
      TYPE *,'  4.  A motorized rifle company is in a defensive'
      TYPE *,'      formation and is expected to defend in place. '
      TYPE *,'  5.  A motorized rifle company is in a defensive'
      TYPE *,'      formation and is expected to delay. '
      CALL TIME_RESP ( LAST1, TS1TIM, TS1ATT,
     1                    CORR_ANS, QUEST_NUM )
C
      CALL CLR_SCRN
      CORR_ANS = 2
      QUEST_NUM = 14
      TYPE *,'What is the disposition of enemy forces on Objective D?'
      TYPE *,' '
      TYPE *,'  1.  A motorized rifle company is in a defensive'
      TYPE *,'      formation with 7 BMPs and is expected to defend'
      TYPE *,'      in place. '
      TYPE *,'  2.  A motorized rifle company is in a defensive'
      TYPE *,'      formation with 7 BMPs and is expected to delay. '
      TYPE *,'  3.  A motorized rifle platoon is in a defensive'
      TYPE *,'      formation with 4 BMPs and is expected to defend'
      TYPE *,'      in place. '
      TYPE *,'  4.  A motorized rifle company is in a defensive'
      TYPE *,'      formation with 9 BMPs and is expected to delay. '
      TYPE *,'  5.  A motorized rifle company is in a defensive'
      TYPE *,'      formation with 9 BMPs and is expected to defend'
      TYPE *,'      in place. '
      CALL TIME_RESP ( LAST1, TS1TIM, TS1ATT,
     1                    CORR_ANS, QUEST_NUM )
C
      CALL CLR_SCRN
      CORR_ANS = 3
      QUEST_NUM = 15
      TYPE *,'What is the most likely enemy course of action?'
      TYPE *,' '
      TYPE *,'  1.  Continue to delay. '
      TYPE *,'  2.  Defend in place from current positions. '
      TYPE *,'  3.  Delay until grid line 57 and then defend in place. '
      TYPE *,'  4.  Counterattack through Objective E. '
      TYPE *,'  5.  2d echelon forces attack through 1st echelon '
      CALL TIME_RESP ( LAST1, TS1TIM, TS1ATT,
     1                    CORR_ANS, QUEST_NUM )
C
      CALL CLR_SCRN
      CORR_ANS = 1
      QUEST_NUM = 16
      TYPE *,'What special capabilities does the opposing MRB have?'
      TYPE *,'(Note - do not consider the artillery)'
      TYPE *,' '
      TYPE *,'  1.  Engineer, chemical and bridging '
      TYPE *,'  2.  Engineer, chemical, bridging and nuclear '
      TYPE *,'  3.  Chemical, bridging and nuclear. '
      TYPE *, '  4. Engineer, chemical and nuclear.'
      TYPE *, '  5. Engineer, bridging and nuclear.'
      CALL TIME_RESP ( LAST1, TS1TIM, TS1ATT,
     1                 CORR_ANS, QUEST_NUM )
C
      CALL CLR_SCRN
      CORR_ANS = 4
      QUEST_NUM = 17
      TYPE *,'Which task force company or team has the'
      TYPE *,'highest personnel status?'
      TYPE *,' '
      TYPE *,'  1. Team A'
      TYPE *,'  2. Company B'
      TYPE *,'  3. Company C'
      TYPE *,'  4. Team D'
      CALL TIME_RESP ( LAST1, TS1TIM, TS1ATT,
     1                 CORR_ANS, QUEST_NUM )
C
      CALL CLR_SCRN
      CORR_ANS = 2
      QUEST_NUM = 18
      TYPE *,'What mission is currently assigned to the heavy mortar'
      TYPE *,'platoon?'
      TYPE *,' '
      TYPE *,'  1. DS to Team D.'
      TYPE *,'  2. GS to the task force.'
      TYPE *,'  3. DS to Company B.'
      TYPE *,'  4. DS to Company C.'
      TYPE *,'  5. DS to Team A.'
      CALL TIME_RESP ( LAST1, TS1TIM, TS1ATT,
     1                 CORR_ANS, QUEST_NUM )
C
      CALL CLR_SCRN
      CORR_ANS = 3
      QUEST_NUM = 19
      TYPE *,'With which unit(s) does the task force not have'
      TYPE *,'secure communications?'
      TYPE *,' '
      TYPE *,'  1. Team A'
      TYPE *,'  2. Team D'
      TYPE *,'  3. Company C'
      TYPE *,'  4. Company B and Company C'
      TYPE *,'  5. Scout Platoon'
      TYPE *,'  6. Heavy Mortar Platoon'
      TYPE *,'  7. Antitank Platoon'
      CALL TIME_RESP ( LAST1, TS1TIM, TS1ATT,
     1                 CORR_ANS, QUEST_NUM )
C
C     *** PHASE III GENERAL SITUATION ***
C
      CALL CLR_SCRN
      TYPE *, 'END OF PHASE II (OFFENSE)'
      TYPE *, ' '
      TYPE *,'This is Phase III (Offense). Ask the experiment monitor'
      TYPE *,'to display the Phase III situation.'
      TYPE *, ' '
      TYPE *,'The time is H+6 hours (021215). Further casualties have'
      TYPE *,'been suffered. The task force has secured Objectives C'
      TYPE *,'and D but the advance has slowed due to increased enemy'
      TYPE *,'resistance.'
      TYPE *,' '
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        TYPE *,'Read the Phase III (Offense) message traffic.'
        TYPE *,'This traffic was received after the start'
        TYPE *,'of Phase II and prior to Phase III.'
        TYPE *, ' '
        TYPE *, 'TYPE: "C" WHEN READY FOR PHASE III QUESTIONS.'
        TYPE *,'REMEMBER, YOU WILL BE ASKED TO DEFEND YOUR ANSWERS.'
        TYPE *, ' '
C
        PAUSE
C
C       *** PHASE III QUESTIONS ***
C
        CALL CLR_SCRN
        QUEST_NUM = 26
        TYPE *,'In view of the current situation, what action'
        TYPE *,'would you take to secure Objective E?'
        TYPE *,' '
        TYPE *,'  1. Have Team D hold its present position and'
        TYPE *,'     direct Team A to pass through D and secure'
        TYPE *,'     Objective E.'
        TYPE *,'  2. Hold Team D in place until Team A can come'
        TYPE *,'     abreast. Then attack the objective with'
        TYPE *,'     both teams on line.'
        TYPE *,'  3. Assuming permission has been granted to fire'
        TYPE *,'     into 3d Brigade''s zone, direct Team A to'
        TYPE *,'     suppress by fire enemy elements on the high'
        TYPE *,'     ground north of Objective E while Team D'
        TYPE *,'     continues the attack to the objective.'
        TYPE *,'  4. Continue the attack exactly as planned by'
        TYPE *,'     the OPORD.'
        TYPE *,'  5. Other.'
        CALL RCD_ANS ( LAST1, TS1TIM, TS1ATT, QUEST_NUM )
        TYPE *,' '
        TYPE *,'State why you selected this course of action on the'
        TYPE *,'form provided.'
        TYPE *, ' '
        TYPE *, 'TYPE: "C" WHEN READY TO CONTINUE'
C
        PAUSE
C
        CALL CLR_SCRN
        QUEST_NUM = 27
        TYPE *,'In view of the current situation, what action'
        TYPE *,'would you take to secure Objective F?'
        TYPE *,' '
        TYPE *,'  1. Hold Company C in place until Company B'
        TYPE *,'     can come on line and then attack the'
        TYPE *,'     objective with the two companies on line.'
        TYPE *,'  2. Hold Company C in its present position and'
        TYPE *,'     direct Company B secure Objective F with'
        TYPE *,'     Company C supporting by fire.'
        TYPE *,'  3. Redefine Company C''s boundary to include the'
        TYPE *,'     high ground between Objectives E and F. Direct'
        TYPE *,'     Company C to secure that high ground and Company'
        TYPE *,'     B to secure Objective F.'
        TYPE *,'  4. Continue the attack exactly as planned by'
        TYPE *,'     the OPORD.'
        TYPE *,'  5. Other.'
        CALL RCD_ANS ( LAST1, TS1TIM, TS1ATT, QUEST_NUM )
        TYPE *,' '
        TYPE *,'State why you selected this course of action on the'
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      TYPE *,'form provided.'
      TYPE *,  ' '
      TYPE *,  'TYPE: "C" WHEN READY TO CONTINUE'
C
      PAUSE
C
      CALL CLR_SCRN
      QUEST_NUM = 28
      TYPE *,'Based on your previous decisions, how would you'
      TYPE *,'alter the mission assigned to the Heavy Mortar'
      TYPE *,'Platoon?'
      TYPE *,' '
      TYPE *,'  1.  DS Team A.'
      TYPE *,'  2.  DS Team D.'
      TYPE *,'  3.  DS Company B.'
      TYPE *,'  4.  DS Company C.'
      TYPE *,'  5.  Remain GS.'
      CALL RCD_ANS ( LAST1, TS1TIM, TS1ATT, QUEST_NUM )
C
      CALL CLR_SCRN
      TYPE *,  'END OF TACTICAL SITUATION #1 (OFFENSE)'
      CALL OUT_DATA
      TYPE *,  ' '
      TYPE *,  'TYPE: "C" WHEN READY FOR NEXT EVENT'
C
      PAUSE
C
      GO TO 50
C
C     *** END OF TACTICAL SITUATION #1 ***
C
C     *** START TACTICAL SITUATION #2 ***
C
  200 CALL CLR_SCRN
C
      CALL SETUP_TACS ( 2, LAST2, MAX_SUBJS )
C
      TYPE *,' '
      TYPE *,'This is a defensive tactical situation in which your'
      TYPE *,'battalion task force must operate against an enemy'
      TYPE *,'motorized rifle regiment.  The experiment monitor'
      TYPE *,'will now brief the operation.   See OPORD 2-85.'
      TYPE *,  ' '
      TYPE *,  'TYPE: "C" TO CONTINUE'
C
      PAUSE
C
C     *** PHASE I GENERAL SITUATION ***
C
      CALL CLR_SCRN
      TYPE *,'This is Phase I (Defense). Ask the experiment monitor'
      TYPE *,'to display the Phase I situation.'
      TYPE *,  ' '
      TYPE *,'The time is 2 hours prior to expected enemy contact'
      TYPE *,'(020400). The covering force has withdrawn and conducted'
      TYPE *,'a passage of lines through the designated passage point.'
      TYPE *,'The Scout Platoon has passed through task force lines as'
      TYPE *,'well and is screening the southern flank. All task force'
      TYPE *,'units are in position and have completed their defensive'
      TYPE *,'preparations. Several obstacles have been executed'
      TYPE *,'and a current Intelligence Summary has been received'
      TYPE *,'from Brigade.'
      TYPE *,' '
      TYPE *,'Read the Phase I message traffic. Note this'
      TYPE *,'traffic was received since the OPORD was issued and'
      TYPE *,'prior to Phase I.'
      TYPE *, ' '
      TYPE *,'TYPE: "C" TO BEGIN PHASE I QUESTIONS. BE SURE TO SELECT'
      TYPE *,'THE BEST ANSWER FOR MULTIPLE CHOICE QUESTIONS.'
      TYPE *, ' '
C
      PAUSE
C
C     *** PHASE I QUESTIONS ***
C
      CALL CLR_SCRN
      CORR_ANS = 3
      TYPE *,'How many mechanized infantry companies are within'
      TYPE *,'the battalion task force?'
      CALL CHK_ANS ( CORR_ANS )
C
      CALL CLR_SCRN
      CORR_ANS = 1
      TYPE *,'How many tank companies are within the battalion'
      TYPE *,'task force?'
      CALL CHK_ANS ( CORR_ANS )
C
      CALL CLR_SCRN
      CORR_ANS = 0
      TYPE *,'How many task force tactical communication links'
      TYPE *,'are working but are nonsecure?'
      CALL CHK_ANS ( CORR_ANS )
C
      CALL CLR_SCRN
      CORR_ANS = 4
      TYPE *,'How many task force heavy mortars are operational?'
      CALL CHK_ANS ( CORR_ANS )
C
      CALL CLR_SCRN
      CORR_ANS = 3
      TYPE *,'Which task force unit has the greatest number of'
      TYPE *,'TOW assets?'
      TYPE *,' '
      TYPE *,'  1.  Team A'
      TYPE *,'  2.  Company B'
      TYPE *,'  3.  Team C'
      TYPE *,'  4.  Team D'
      TYPE *,'  5.  Scout Platoon'
      TYPE *,'  6.  Heavy Mortar Platoon'
      CALL CHK_ANS ( CORR_ANS )
C
      CALL CLR_SCRN
      CORR_ANS = 4
      TYPE *,'Which task force unit has the greatest number of'
      TYPE *,'tank assets?'
      TYPE *,' '
      TYPE *,'  1.  Team A'
      TYPE *,'  2.  Company B'
      TYPE *,'  3.  Team C'
      TYPE *,'  4.  Team D'
      TYPE *,'  5.  Scout Platoon'
      TYPE *,'  6.  Heavy Mortar Platoon'
      CALL CHK_ANS ( CORR_ANS )
C
      CALL CLR_SCRN
      CORR_ANS = 3
      TYPE *,'Which, if any, task force unit has an emergency'
      TYPE *,'resupply request for fuel?'
      TYPE *,' '
      TYPE *,'  1. Team A'
      TYPE *,'  2. Company B'
      TYPE *,'  3. Team C'
      TYPE *,'  4. Team D'
      TYPE *,'  5. Scout Platoon'
      TYPE *,'  6. Heavy Mortar Platoon'
      CALL CHK_ANS ( CORR_ANS )
C
      CALL CLR_SCRN
      CORR_ANS = 5
      TYPE *,'Which task force unit has the greatest need for'
      TYPE *,'ammunition?'
      TYPE *,' '
      TYPE *,'  1. Team A'
      TYPE *,'  2. Company B'
      TYPE *,'  3. Team C'
      TYPE *,'  4. Team D'
      TYPE *,'  5. Scout Platoon'
      TYPE *,'  6. Heavy Mortar Platoon'
      CALL CHK_ANS ( CORR_ANS )
C
      CALL CLR_SCRN
      CORR_ANS = 1
      TYPE *,'Which task force unit has priority of fires from'
      TYPE *,'the heavy mortar platoon?'
      TYPE *,' '
      TYPE *,'  1. Team A'
      TYPE *,'  2. Company B'
      TYPE *,'  3. Team C'
      TYPE *,'  4. Team D'
      TYPE *,'  5. Scout Platoon'
      TYPE *,'  6. None. The mortars are in general support'
      CALL CHK_ANS ( CORR_ANS )
C
      CALL CLR_SCRN
      CORR_ANS = 3
      TYPE *,'What is Team A''s personnel, weapons and equipment'
      TYPE *,'status?'
      TYPE *,' '
      TYPE *,'  1. Personnel > 50, Weapons > 75, Equipment > 50'
      TYPE *,'  2. Personnel > 75, Weapons > 50, Equipment > 50'
      TYPE *,'  3. Personnel > 75, Weapons > 75, Equipment > 75'
      TYPE *,'  4. Personnel > 50, Weapons > 50, Equipment > 75'
      TYPE *,'  5. Personnel > 50, Weapons > 50, Equipment > 50'
      CALL CHK_ANS ( CORR_ANS )
C
      CALL CLR_SCRN
      TYPE *,'The following questions require the map frame directly'
      TYPE *,'east of the one you see.  Ask the experiment monitor to'
      TYPE *,'display the next frame and overlay before you proceed.'
      TYPE *, ' '
      TYPE *, 'TYPE: "C" TO CONTINUE'
C
      PAUSE
```

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C
      CALL CLR_SCRN
      CORR_ANS = 39
      TYPE *,'How many enemy tanks have been identified approaching'
      TYPE *,'the task force position?'
      CALL CHK_ANS ( CORR_ANS )
C
      CALL CLR_SCRN
      CORR_ANS = 2
      TYPE *,'How many motorized rifle battalions are within'
      TYPE *,'2 kilometers of the Fulda River?'
      CALL CHK_ANS ( CORR_ANS )
C
      CALL CLR_SCRN
      CORR_ANS = 3
      TYPE *,'How many enemy motorized rifle battalions have a'
      TYPE *,'chemical capability?'
      CALL CHK_ANS ( CORR_ANS )
C
      CALL CLR_SCRN
      CORR_ANS = 6
      TYPE *,'How many enemy self-propelled artillery pieces'
      TYPE *,'have been reported?'
      CALL CHK_ANS ( CORR_ANS )
C
      CALL CLR_SCRN
      CORR_ANS = 2
      TYPE *,'What is the current disposition and composition'
      TYPE *,'of the first echelon motorized rifle battalions?'
      TYPE *,' '
      TYPE *,'  1. The MRBs are in march column, each travelling west'
      TYPE *,'     with 30 BMPs, 10 tanks and 3 BRDMs.'
      TYPE *,'  2. The MRBs are in march column, each travelling west'
      TYPE *,'     with 34 BMPs, 13 tanks and 3 BRDMs.'
      TYPE *,'  3. The MRBs are in an attack formations, each heading'
      TYPE *,'     west with 30 BMPs, 10 tanks and 3 BRDMs.'
      TYPE *,'  4. The MRBs are in an attack formations, each heading'
      TYPE *,'     west with 34 BMPs, 13 tanks and 3 BRDMs.'
      TYPE *,'  5. The MRBs are stationary, each with 34 BMPs,'
      TYPE *,'     13 tanks and 3 BRDMs.'
      CALL CHK_ANS ( CORR_ANS )
C
C     *** PHASE II GENERAL SITUATION ***
C
      CALL CLR_SCRN
      TYPE *, 'END OF PHASE I (DEFENSE)'
      TYPE *, ' '
      TYPE *,'This is Phase II (Defense). Ask the experiment monitor'
      TYPE *,'to display the Phase II situation.'
      TYPE *, ' '
      TYPE *,'The time is 5 hours after enemy contact began (021100) '
      TYPE *,'Enemy units continue to advance and 1st echelon elements'
      TYPE *,'have crossed the Fulda River  Forward units of the task'
      TYPE *,'force are in contact and casualties have been suffered'
      TYPE *,'on both sides. The task force rear area is receiving'
      TYPE *,'enemy preparatory fires.'
      TYPE *, ' '
      TYPE *,'Read the Phase II message traffic. This traffic'
      TYPE *,'was received after the start of Phase I and'
      TYPE *,'prior to Phase II.'
      TYPE *,' '
      TYPE *,  'TYPE:  "C" WHEN READY FOR PHASE II QUESTIONS.  BE SURE TO'
      TYPE *, 'SELECT THE BEST ANSWER FOR MULTIPLE CHOICE QUESTIONS AND'
      TYPE *, 'ANSWER AS ACCURATELY AS POSSIBLE, IN AS LITTLE TIME AS'
      TYPE *, 'POSSIBLE.'
      TYPE *,  ' '
C
      PAUSE
C
C     *** PHASE II QUESTIONS ***
C
      CALL CLR_SCRN
      CORR_ANS = 4
      QUEST_NUM = 1
      TYPE *, 'How many operational tanks are at Team A''s battle'
      TYPE *, 'position?'
      CALL TIME_RESP ( LAST2, TS2TIM, TS2ATT,
     1                 CORR_ANS, QUEST_NUM )
C
      CALL CLR_SCRN
      CORR_ANS = 1
      QUEST_NUM = 2
      TYPE *, 'How many task force communication links are presently'
      TYPE *, 'down?'
      CALL TIME_RESP ( LAST2, TS2TIM, TS2ATT,
     1                 CORR_ANS, QUEST_NUM )
C
      CALL CLR_SCRN
      CORR_ANS = 2
      QUEST_NUM = 3
      TYPE *, 'How many task force units have an ammunition status of'
      TYPE *, '75 percent or below?'
      CALL TIME_RESP ( LAST2, TS2TIM, TS2ATT,
     1                 CORR_ANS, QUEST_NUM )
C
      CALL CLR_SCRN
      CORR_ANS = 15
      QUEST_NUM = 4
      TYPE *, 'How many enemy tanks have been identified near'
      TYPE *, 'the west edge of Engagement Area Red?'
      CALL TIME_RESP ( LAST2, TS2TIM, TS2ATT,
     1                 CORR_ANS, QUEST_NUM )
C
      CALL CLR_SCRN
      CORR_ANS = 6
      QUEST_NUM = 5
      TYPE *, 'How many enemy anti-air vehicles are'
      TYPE *, 'currently reported?'
      CALL TIME_RESP ( LAST2, TS2TIM, TS2ATT,
     1                 CORR_ANS, QUEST_NUM )
C
      CALL CLR_SCRN
      CORR_ANS = 1
      QUEST_NUM = 6
      TYPE *, 'How many task force companies or teams'
      TYPE *, '(Team A, Co B, Team C, Team D) have a'
      TYPE *, 'personnel strength at or below 75 percent?'
      CALL TIME_RESP ( LAST2, TS2TIM, TS2ATT,
     1                 CORR_ANS, QUEST_NUM )
C
      CALL CLR_SCRN
      CORR_ANS = 4
      QUEST_NUM = 7
      TYPE *,'How many task force heavy mortars are operational?'
      CALL TIME_RESP ( LAST2, TS2TIM, TS2ATT,
     1                 CORR_ANS, QUEST_NUM )
C
      CALL CLR_SCRN
      CORR_ANS = 3
      QUEST_NUM = 8
      TYPE *,'How many motorized rifle battalions are moving'
      TYPE *,'towards the task force zone of action?'
      CALL TIME_RESP ( LAST2, TS2TIM, TS2ATT,
     1                 CORR_ANS, QUEST_NUM )
C
      CALL CLR_SCRN
      CORR_ANS = 2
      QUEST_NUM = 9
      TYPE *,'Of these motorized rifle battalions, how many'
      TYPE *,'have deployed into attack formations?'
      CALL TIME_RESP ( LAST2, TS2TIM, TS2ATT,
     1                 CORR_ANS, QUEST_NUM )
C
      CALL CLR_SCRN
      CORR_ANS = 4
      QUEST_NUM = 10
      TYPE *,'How many and what type of major weapons are'
      TYPE *,'currently operational with Team C?'
      TYPE *,' '
      TYPE *,'  1. 9 APCs, 10 TOWs, 4 Dragons, 3 Mortars.'
      TYPE *,'  2. 8 APCs, 4 TOWs, 4 Dragons, 3 Mortars.'
      TYPE *,'  3. 7 APCs, 8 TOWs, 13 Dragons, 3 Mortars.'
      TYPE *,'  4. 8 APCs, 9 TOWs, 5 Dragons, 3 Mortars.'
      TYPE *,'  5. 9 APCs, 13 TOWs, 12 Dragons, 3 Mortars.'
      CALL TIME_RESP ( LAST2, TS2TIM, TS2ATT,
     1                 CORR_ANS, QUEST_NUM )
C
      CALL CLR_SCRN
      CORR_ANS = 3
      QUEST_NUM = 11
      TYPE *,'What is the composition of the enemy force'
      TYPE *,'near Battle Position 2?'
      TYPE *,' '
      TYPE *,'  1. An MRB composed of 1 tank platoon, 3 motorized'
      TYPE *,'     rifle companies plus an air-defense company.'
      TYPE *,'  2. An MRB composed of 1 tank company, 2 motorized'
      TYPE *,'     rifle companies plus an air-defense company.'
      TYPE *,'  3. An MRB composed of 1 tank company, 3 motorized'
      TYPE *,'     rifle companies plus an air-defense company.'
      TYPE *,'  4. An MRB composed of 4 motorized rifle companies'
      TYPE *,'     plus an air-defense company.'
      TYPE *,'  5. An MRB composed of 1 tank company and'
      TYPE *,'     4 motorized rifle companies.'
      CALL TIME_RESP ( LAST2, TS2TIM, TS2ATT,
     1                 CORR_ANS, QUEST_NUM )
C
      CALL CLR_SCRN
      CORR_ANS = 3
      QUEST_NUM = 12
      TYPE *,'What is Team D''s ammunition and POL status?'
      TYPE *,' '
      TYPE *,'  1. Ammunition > 50, POL > 75'
      TYPE *,'  2. Ammunition > 50, POL > 50'
      TYPE *,'  3. Ammunition > 75, POL > 50'
      TYPE *,'  4. Ammunition > 25, POL > 50'
      TYPE *,'  5. Ammunition > 75, POL > 75'
      CALL TIME_RESP ( LAST2, TS2TIM, TS2ATT,
     1                 CORR_ANS, QUEST_NUM )
C
      CALL CLR_SCRN
      CORR_ANS = 4
      QUEST_NUM = 13
      TYPE *,'What are the actions of enemy second echelon'
      TYPE *,'forces?'
      TYPE *,' '
      TYPE *,'  1. A motorized rifle company in march column heading'
      TYPE *,'     west with lead elements at the south-east corner'
      TYPE *,'     of the task force zone.'
      TYPE *,'  2. A motorized rifle company in attack formation head-'
      TYPE *,'     ing west with lead elements at the south-east'
      TYPE *,'     corner of the task force zone.'
      TYPE *,'  3. A motorized rifle battalion in attack formation'
      TYPE *,'     heading west with lead elements at the south-east'
      TYPE *,'     corner of the task force zone.'
      TYPE *,'  4. A motorized rifle battalion in march column heading'
      TYPE *,'     west with lead elements at the south-east corner'
      TYPE *,'     of the task force zone.'
      TYPE *,'  5. A tank battalion in march column heading'
      TYPE *,'     west with lead elements at the south-east corner'
      TYPE *,'     of the task force zone.'
      CALL TIME_RESP ( LAST2, TS2TIM, TS2ATT,
     1                 CORR_ANS, QUEST_NUM )
C
      CALL CLR_SCRN
      CORR_ANS = 1
      QUEST_NUM = 14
      TYPE *,'What is the disposition of enemy 1st echelon forces?'
      TYPE *,' '
      TYPE *,'  1. Two MRBs each with 1 tank company and 3 motorized'
      TYPE *,'     rifle companies in attack formations.'
      TYPE *,'  2. One MRB with 1 tank company and 3 motorized'
      TYPE *,'     rifle companies in attack formations.'
      TYPE *,'  3. Two MRBs each with 1 tank platoon and 3 motorized'
      TYPE *,'     rifle companies in attack formations.'
      TYPE *,'  4. Two tank battalions each with 3 tank companies'
      TYPE *,'     and 1 motorized rifle company in attack formations.'
      TYPE *,'  5. Two tank battalions each with 1 tank company'
      TYPE *,'     and 3 motorized rifle companies in attack'
      TYPE *,'     formations.'
      CALL TIME_RESP ( LAST2, TS2TIM, TS2ATT,
     1                 CORR_ANS, QUEST_NUM )
C
      CALL CLR_SCRN
      CORR_ANS = 5
      QUEST_NUM = 15
      TYPE *,'What is the most likely enemy course of action?'
      TYPE *,' '
      TYPE *,'  1. Conduct a breakthrough along the avenue of approach'
      TYPE *,'     through Engagement Area Tan and Company B''s'
      TYPE *,'     position.'
      TYPE *,'  2. Attack across a wide frontage to destroy the entire'
      TYPE *,'     task force.'
      TYPE *,'  3. The 1st echelon will hold present positions and'
      TYPE *,'     allow the 2d echelon to attack through to the west.'
      TYPE *,'  4. Hold present positions and await reinforcements '
      TYPE *,'  5. Conduct a breakthrough along the avenue of approach'
      TYPE *,'     through Team A''s position to the west. '
      CALL TIME_RESP ( LAST2, TS2TIM, TS2ATT,
     1                 CORR_ANS, QUEST_NUM )
C
      CALL CLR_SCRN
      CORR_ANS = 1
      QUEST_NUM = 16
      TYPE *,'What special capabilities do the enemy motorized rifle'
      TYPE *,'battalions in the 1st echelon have?'
      TYPE *,'(Note - do not consider the artillery)'
      TYPE *,' '
      TYPE *,'  1. Engineer, chemical and bridging. '
      TYPE *,'  2. Engineer, chemical, bridging and nuclear. '
      TYPE *,'  3. Chemical, bridging and nuclear. '
      TYPE *,'  4. Engineer, chemical and nuclear. '
      TYPE *,'  5. Engineer, bridging and nuclear '
      CALL TIME_RESP ( LAST2, TS2TIM, TS2ATT,
     1                 CORR_ANS, QUEST_NUM )
C
      CALL CLR_SCRN
      CORR_ANS = 1
      QUEST_NUM = 17
      TYPE *,'Which task force company or team'
      TYPE *,'has the lowest personnel status?'
      TYPE *,' '
      TYPE *,'  1. Team A'
      TYPE *,'  2. Company B'
      TYPE *,'  3. Team C'
      TYPE *,'  4. Team D'
      CALL TIME_RESP ( LAST2, TS2TIM, TS2ATT,
     1                 CORR_ANS, QUEST_NUM )
C
      CALL CLR_SCRN
      CORR_ANS = 5
      QUEST_NUM = 18
      TYPE *,'What mission is currently assigned to the heavy mortar'
      TYPE *,'platoon?'
      TYPE *,' '
      TYPE *,'  1. GS to the task force. '
      TYPE *,'  2. DS to Team D. '
      TYPE *,'  3. DS to Company B. '
      TYPE *,'  4. DS to Company C. '
      TYPE *,'  5. DS to Team A. '
      CALL TIME_RESP ( LAST2, TS2TIM, TS2ATT,
     1                 CORR_ANS, QUEST_NUM )
C
      CALL CLR_SCRN
      CORR_ANS = 2
      QUEST_NUM = 19
      TYPE *,'With which unit(s) does the task force not have'
      TYPE *,'secure communications?'
      TYPE *,' '
      TYPE *,'  1. Team A'
      TYPE *,'  2. Team A and Team D'
      TYPE *,'  3. Team C'
      TYPE *,'  4. Company B and Team C'
      TYPE *,'  5. Scout Platoon'
      TYPE *,'  6. Heavy Mortar Platoon'
      CALL TIME_RESP ( LAST2, TS2TIM, TS2ATT,
     1                    CORR_ANS, QUEST_NUM )
C
C      *** PHASE III GENERAL SITUATION ***
C
       CALL CLR_SCRN
       TYPE *, 'END OF PHASE II (DEFENSE)'
       TYPE *,  ' '
       TYPE *,'This is Phase III (Defense). Ask the experiment monitor'
       TYPE *,'to display the Phase III situation.'
       TYPE *,  ' '
       TYPE *,'The time is now 2 hours later (7 hours after initial'
       TYPE *,'enemy contact-021300). Most of the task force is now in'
       TYPE *,'contact and the enemy advance is slowing. Enemy'
       TYPE *,'preparatory fires continue into the task force zone'
       TYPE *,'and further casualties have been suffered.'
       TYPE *,' '
       TYPE *,'Read the Phase III (Defense) message traffic.'
       TYPE *,'This traffic was received after the start'
       TYPE *,'of Phase II and prior to Phase III.'
       TYPE *,  ' '
       TYPE *,  'TYPE: "C" WHEN READY FOR PHASE III QUESTIONS.'
       TYPE *,'REMEMBER, YOU WILL BE ASKED TO DEFEND YOUR ANSWERS.'
       TYPE *,  ' '
C
       PAUSE
C
C      *** PHASE III QUESTIONS ***
C
       CALL CLR_SCRN
       QUEST_NUM = 26
       TYPE *,'Enemy forces have penetrated Battle Position 1. What'
       TYPE *,'actions would you take to contain the penetration?'
       TYPE *,' '
       TYPE *,'  1. Direct Team A to displace to BP 5 (where a cache'
       TYPE *,'     of ammunition has been staged), occupy and hold'
       TYPE *,'     that position.'
       TYPE *,'  2. Direct Team A to displace to BP 5 and reinforce'
       TYPE *,'     the team with 1 platoon from Company B.'
       TYPE *,'  3. Direct Company B to counterattack enemy elements'
       TYPE *,'     near BP 1 through Team A''s position.'
       TYPE *,'  4. Continue the mission with no change from the OPORD.'
       TYPE *,'  5. Other.'
       CALL RCD_ANS ( LAST2, TS2TIM, TS2ATT, QUEST_NUM )
       TYPE *,' '
       TYPE *,'State why you selected this course of action on the'
       TYPE *,'form provided.'
       TYPE *,  ' '
       TYPE *,  'TYPE: "C" WHEN READY TO CONTINUE'
C
       PAUSE
C
       CALL CLR_SCRN
       QUEST_NUM = 27
       TYPE *,'In view of the current situation, what action would'
       TYPE *,'you take regarding the northern flank of your zone?'
       TYPE *,' '
       TYPE *,'  1. Direct Team D to displace to BP 7 (where a cache of'
       TYPE *,'     ammunition has been staged), occupy and hold that'
       TYPE *,'     position.'
       TYPE *,'  2. Reinforce Team D on BP 2 with one platoon from'
       TYPE *,'     Team C.'
```

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        TYPE *,'  3. Reinforce Team D on BP 2 with one TOW section from'
        TYPE *,'     Team C and one from Company B.'
        TYPE *,'  4. Continue the mission with no change from the OPORD.'
        TYPE *,'  5. Other.'
        CALL RCD_ANS ( LAST2, TS2TIM, TS2ATT, QUEST_NUM )
        TYPE *,' '
        TYPE *,'State why you selected this course of action on the'
        TYPE *,'form provided.'
        TYPE *, ' '
        TYPE *, 'TYPE: "C" WHEN READY TO CONTINUE'
C
        PAUSE
C
        CALL CLR_SCRN
        QUEST_NUM = 28
        TYPE *,'Based on your previous decisions, how would you'
        TYPE *,'alter the mission assigned to the Heavy Mortar'
        TYPE *,'Platoon?'
        TYPE *,' '
        TYPE *,'  1. DS Team A.'
        TYPE *,'  2. DS Team D.'
        TYPE *,'  3. DS Company B.'
        TYPE *,'  4. DS Team C.'
        TYPE *,'  5. Place in GS.'
        CALL RCD_ANS ( LAST2, TS2TIM, TS2ATT, QUEST_NUM )
C
        CALL CLR_SCRN
        TYPE *, 'END OF TACTICAL SITUATION #2 (DEFENSE)'
        CALL OUT_DATA
        TYPE *, ' '
        TYPE *, 'TYPE: "C" WHEN READY FOR NEXT EVENT'
C
        PAUSE
C
        GO TO 50
C
C       *** END OF TACTICAL SITUATION #2 (DEFENSE) ***
C
C       *** END OF THE LAST TACTICAL SITUATION ***
C
        END
```

```
C
C
C
C      *** PURPOSE ***
C      THIS SUBROUTINE SETS-UP THE EXPERIMENT TRIAL BY INCREMENTING
C      THE SUBJECT NUMBER AND DISPLAYING ARRAY-FILL INFORMATION.
C
       SUBROUTINE SETUP_TACS (TACSRO, SUBNUM, MAXSUB )
C
C      *** VARIABLE DEFINITIONS ***
C      SUBNUM = SUBJECT NUMBER
C      MAXSUB = MAX NUMBER OF SUBJECTS
C      TACSRO = TACTICAL SITUATION NUMBER
C      ANSWER = ANSWER
C
       INTEGER SUBNUM, MAXSUB, TACSRO
       CHARACTER*1 ANSWER
C
       CALL CLR_SCRN
       SUBNUM = SUBNUM + 1
C
       TYPE *, 'THIS IS SITUATION NUMBER:     ', TACSRO
       TYPE *, 'MAXIMUM NUMBER OF SUBJECTS:   ', MAXSUB
       TYPE *, 'CURRENT SUBJECT NUMBER IS:    ', SUBNUM
C
       IF (SUBNUM.GT.MAXSUB) THEN
          TYPE *, 'ERROR: MAX NUMBER OF SUBJECTS EXCEEDED.'
          TYPE *, 'PROGRAM WILL STOP AUTOMATICALLY.'
C
          TYPE *, 'PROGRAM IS OVER'
C
          STOP
C
       END IF
       TYPE *, ' '
       TYPE *, ' '
       TYPE *, 'DO YOU WANT TO STOP THE EXPERIMENT ?'
       TYPE *, '(MOST CURRENT DATA IS ALREADY STORED)'
       TYPE *, ' '
       TYPE *, ' '
       TYPE *, 'TYPE CHARACTER ( Y OR N )'
C
       CALL READ_ANS ( ANSWER )
C
       IF (ANSWER.EQ.'Y') THEN
C
          TYPE *, 'PROGRAM IS OVER'
C
          STOP
       END IF
C
C
       CALL CLR_SCRN
       TYPE *, 'SUBJECT NUMBER IS:', SUBNUM
       TYPE *, ' '
       TYPE *, ' '
C
       RETURN
       END
```

```
C
C
C
C     *** PURPOSE ***
C     THIS SUBROUTINE CHECKS THE ACCURACY OF THE SUBJECT'S
C     RESPONSE AND RECORDS THE TIME AND NUMBER OF ATTEMPTS
C     TO CORRECT RESPONSE FOR PHASE II QUESTIONS.
C
      SUBROUTINE TIME_RESP ( SUBJ_NUM, TEMP1, TEMP2,
     1                       CORR_ANS, QUEST_NUM )
C
C     *** VARIABLE DEFINITIONS ***
C     TIME_COUNT = ELAPSED TIME
C     DELTA      = TIME PARAMETER FOR SYSTEM ROUTINE SECNDS
C     TEMP1      = TIME TO CORRECT RESPONSE ARRAY
C     TEMP2      = NUMBER OF ATTEMPTS TO CORRECT RESPONSE ARRAY
C     ATTMP_NUM  = ATTEMPT NUMBER
C
      REAL TEMP1 (30,15), TIME_COUNT, DELTA
      INTEGER TEMP2 (30,15), ATTMP_NUM
      INTEGER CORR_ANS, SUBJ_ANS, SUBJ_NUM, QUEST_NUM
C
      ATTMP_NUM = 0
      SUBJ_ANS  = 999999
C
C     *** ZERO AND START THE CLOCK ***
C
      TIME_COUNT = 0.0
      DELTA = SECNDS (0.0)
C
C     *** LOOP UNTIL SUBJECT'S RESPONSE IS CORRECT ***
C
      DO WHILE (SUBJ_ANS.NE.CORR_ANS)
C
         ACCEPT *, SUBJ_ANS
C
         TIME_COUNT = SECNDS(DELTA)
         ATTMP_NUM  = ATTMP_NUM + 1
C
         IF (SUBJ_ANS.NE.CORR_ANS) THEN
            TYPE *, 'ANSWER INCORRECT'
         END IF
C
      END DO
C
C     *** RECORD THE DATA ***
C
         TEMP1(QUEST_NUM,SUBJ_NUM) = TIME_COUNT
         TEMP2(QUEST_NUM,SUBJ_NUM) = ATTMP_NUM
C
      RETURN
      END
```

```
C
C
C
C      *** PURPOSE ***
C      THIS SUBROUTINE CHECKS THE ACCURACY OF THE SUBJECT'S
C      RESPONSE FOR PHASE I QUESTIONS.
C
       SUBROUTINE CHK_ANS ( CORR_ANS )
C
       INTEGER CORR_ANS, SUBJ_ANS
       SUBJ_ANS = 999999
C
C      *** LOOP UNTIL THE SUBJECT'S RESPONSE IS CORRECT ***
C
       DO WHILE (SUBJ_ANS.NE.CORR_ANS)
C
          ACCEPT *, SUBJ_ANS
C
          IF (SUBJ_ANS.NE.CORR_ANS) THEN
             TYPE *, 'ANSWER INCORRECT'
          END IF
C
       END DO
C
       RETURN
       END
C
C
C
C      *** PURPOSE ***
C      THIS SUBROUTINE RECORDS THE SUBJECT'S ANSWER AND
C      TIME TO RESPONSE FOR PHASE III QUESTIONS.
C
       SUBROUTINE RCD_ANS (SUBJ_NUM,TEMP1,TEMP2,QUEST_NUM)
C
C      *** VARIABLE DEFINITIONS ***
C      TIME_COUNT = ELAPSED TIME
C      DELTA      = TIME PARAMETER FOR SYSTEM ROUTINE SECNDS
C      TEMP1      = TIME TO CORRECT RESPONSE ARRAY
C      TEMP2      = NUMBER OF ATTEMPTS TO CORRECT RESPONSE ARRAY
C
       REAL TEMP1 (30,15), TIME_COUNT, DELTA
       INTEGER TEMP2 (30,15), SUBJ_NUM, QUEST_NUM
       INTEGER SUBJ_ANS
C
C      *** ZERO AND START THE CLOCK ***
C
       TIME_COUNT = 0.0
       DELTA = SECNDS (0.0)
C
       ACCEPT *, SUBJ_ANS
       TIME_COUNT = SECNDS(DELTA)
C
C      *** RECORD THE DATA ***
C
       TEMP1(QUEST_NUM, SUBJ_NUM) = TIME_COUNT
       TEMP2(QUEST_NUM, SUBJ_NUM) = SUBJ_ANS
C
       RETURN
       END
```

```
C
C      *** PURPOSE ***
C      THIS SUBROUTINE READS IN THE TIME AND ATTEMPT-NUMBER
C      ARRAYS FROM THE DATA FILES.
C
       SUBROUTINE READ_DATA
C
C      *** FILE DEFINITIONS ***
C      TACS1TIM.DAT = TAC SIT #1 TIME DATA FILE
C      TACS2TIM.DAT = TAC SIT #2 TIME DATA FILE
C      TACS1ATT.DAT = TAC SIT #1 ATTEMPT-NUMBER DATA FILE
C      TACS2ATT.DAT = TAC SIT #2 ATTEMPT-NUMBER DATA FILE
C
C      *** VARIABLE DEFINITIONS ***
C      MAX_SUBJS = MAX NUMBER OF SUBJECTS
C      MAX_QUEST = MAX NUMBER OF QUESTIONS
C      LOG_UNIT  = LOGICAL UNIT NUMBER
C      LAST1     = TAC SIT #1 CURRENT SUBJECT NUMBER
C      LAST2     = TAC SIT #2 CURRENT SUBJECT NUMBER
C      TS1ATT    = TAC SIT #1 ARRAY OF NUMBER OF ATTEMPTS
C                  TO CORRECT RESPONSE FOR EACH PHASE II
C                  QUESTION
C      TS2ATT    = TAC SIT #2 ARRAY OF NUMBER OF ATTEMPTS
C                  TO CORRECT RESPONSE FOR EACH PHASE II
C                  QUESTION
C      TS1TIM    = TAC SIT #1 ARRAY OF TIME TO CORRECT
C                  RESPONSE FOR EACH PHASE II QUESTION
C                  AND TIME TO RESPONSE FOR EACH PHASE III
C                  QUESTION
C      TS2TIM    = TAC SIT #2 ARRAY OF TIME TO CORRECT
C                  RESPONSE FOR EACH PHASE II QUESTION
C                  AND TIME TO RESPONSE FOR EACH PHASE III
C                  QUESTION
C
       COMMON /A/ TS1TIM,TS2TIM
       COMMON /B/ TS1ATT,TS2ATT
       COMMON /C/ LAST1,LAST2
       COMMON /D/ MAX_SUBJS,MAX_QUEST,LOG_UNIT
C
       REAL TS1TIM (30,15), TS2TIM (30,15)
       INTEGER TS1ATT (30,15), TS2ATT (30,15)
       INTEGER MAX_SUBJS, MAX_QUEST
       INTEGER LAST1, LAST2
C
       CALL READ_TIMES('TACS1TIM.DAT', TS1TIM,
      1                 LOG_UNIT,MAX_QUEST,
      2                 MAX_SUBJS, LAST1 )
C
       CALL READ_ATMPS('TACS1ATT.DAT', TS1ATT,
      1                 LOG_UNIT, MAX_QUEST,
      2                 MAX_SUBJS,LAST1 )
C
       CALL READ_TIMES('TACS2TIM.DAT', TS2TIM,
      1                 LOG_UNIT, MAX_QUEST,
      2                 MAX_SUBJS, LAST2 )
C
       CALL READ_ATMPS('TACS2ATT.DAT', TS2ATT,
      1                 LOG_UNIT, MAX_QUEST,
      2                 MAX_SUBJS, LAST2 )


C
       RETURN
       END
```

```
C
C
C
C     *** PURPOSE ***
C     THIS SUBROUTINE READS IN THE TIME DATA ARRAY CALLED
C     BY SUBROUTINE READ_DATA
C
      SUBROUTINE READ_TIMES (FILENAME, TEMP, LU, IMAX, JMAX, PAR1)
C
C     *** VARIABLE DEFINITIONS ***
C     FILENAME = DATA FILE NAME
C     TEMP     = DATA ARRAY
C     LU       = LOGICAL UNIT NUMBER
C     IMAX     = MAX NUMBER OF QUESTIONS
C     JMAX     = MAX NUMBER OF SUBJECTS
C     PAR1     = CURRENT SUBJECT NUMBER
C     I, J     = COUNTERS
C
      REAL TEMP(30, 15)
      INTEGER LU, IMAX, JMAX, PAR1, I, J
      CHARACTER*12 FILENAME
      CHARACTER*12 DUMMY
C
      OPEN (UNIT=LU, FILE=FILENAME )
C
      TYPE *, 'READING FROM: ',FILENAME
      READ (LU, 5) DUMMY
    5 FORMAT (57X, A12)
C
      READ (LU, 10) PAR1
   10 FORMAT (1X, I4)
C
      READ (LU, 20)  (I, (TEMP(I, J), J=1, JMAX ), I =1, IMAX)
   20 FORMAT (1X, I4, 2X, F6. 2, 2X, F6. 2, 2X, F6. 2, 2X, F6. 2, 2X, F6. 2, 2X,
     1F6. 2, 2X, F6. 2, 2X, F6. 2, 2X, F6. 2, 2X, F6. 2, 2X, F6. 2, 2X, F6. 2, 2X,
     2F6. 2, 2X, F6. 2, 2X, F6. 2)
C
      CLOSE (UNIT=LU)
C
      RETURN
      END
```

```
C
C
C
C     *** PURPOSE ***
C     THIS SUBROUTINE READS IN THE ATTEMPT-NUMBER ARRAY CALLED
C     BY SUBROUTINE READ_DATA.
C
      SUBROUTINE READ_ATMPS (FILENAME, TEMP, LU, IMAX, JMAX, PAR1)
C
C     *** VARIABLE DEFINITIONS ***
C     FILENAME = DATA FILE NAME
C     TEMP     = DATA ARRAY
C     LU       = LOGICAL UNIT NUMBER
C     IMAX     = MAX NUMBER OF QUESTIONS
C     JMAX     = MAX NUMBER OF SUBJECTS
C     PAR1     = CURRENT SUBJECT NUMBER
C     I, J     = COUNTERS
C
      INTEGER TEMP (30,15), IMAX, JMAX, LU, PAR1, I, J
      CHARACTER*12 FILENAME
      CHARACTER*12 DUMMY
C
      OPEN (UNIT=LU, FILE=FILENAME )
C
      TYPE *, 'READING FROM: ',FILENAME
      READ (LU,5) DUMMY
    5 FORMAT (41X,A12)
C
      READ (LU,10) PAR1
   10 FORMAT (1X,I4)
C
      READ (LU,20)  (I, (TEMP(I,J), J=1,JMAX), I = 1,IMAX)
   20 FORMAT (1X,I4,2X,I4,2X,I4,2X,I4,2X,I4,2X,I4,2X,I4,2X,
     1I4,2X,I4,2X,I4,2X,I4,2X,I4,2X,I4,2X,I4,2X,I4,2X,I4)
C
      CLOSE(UNIT=LU)
C
      RETURN
      END
```

```
C
C
C
C     *** PURPOSE ***
C     THIS SUBROUTINE WRITES THE TIME AND ATTEMPT-NUMBER
C     ARRAYS TO THE DATA FILES.
C
      SUBROUTINE OUT_DATA
C
C     *** FILE DEFINITIONS ***
C     TACS1TIM.DAT = TAC SIT #1 TIME DATA FILE
C     TACS2TIM.DAT = TAC SIT #2 TIME DATA FILE
C     TACS1ATT.DAT = TAC SIT #1 ATTEMPT-NUMBER DATA FILE
C     TACS2ATT.DAT = TAC SIT #2 ATTEMPT-NUMBER DATA FILE
C
C     *** VARIABLE DEFINITIONS ***
C     MAX_SUBJS = MAX NUMBER OF SUBJECTS
C     MAX_QUEST = MAX NUMBER OF QUESTIONS
C     LOG_UNIT  = LOGICAL UNIT NUMBER
C     LAST1     = TAC SIT #1 CURRENT SUBJECT NUMBER
C     LAST2     = TAC SIT #2 CURRENT SUBJECT NUMBER
C     TS1ATT    = TAC SIT #1 ARRAY OF NUMBER OF ATTEMPTS
C                 TO CORRECT RESPONSE FOR EACH PHASE II
C                 QUESTION
C     TS2ATT    = TAC SIT #2 ARRAY OF NUMBER OF ATTEMPTS
C                 TO CORRECT RESPONSE FOR EACH PHASE II
C                 QUESTION
C     TS1TIM    = TAC SIT #1 ARRAY OF TIME TO CORRECT
C                 RESPONSE FOR EACH PHASE II QUESTION
C                 AND TIME TO RESPONSE FOR EACH PHASE III
C                 QUESTION
C     TS2TIM    = TAC SIT #2 ARRAY OF TIME TO CORRECT
C                 RESPONSE FOR EACH PHASE II QUESTION
C                 AND TIME TO RESPONSE FOR EACH PHASE III
C                 QUESTION
C
      COMMON /A/ TS1TIM, TS2TIM
      COMMON /B/ TS1ATT, TS2ATT
      COMMON /C/ LAST1, LAST2
      COMMON /D/ MAX_SUBJS, MAX_QUEST, LOG_UNIT
C
      REAL TS1TIM (30, 15),  TS2TIM (30, 15)
      INTEGER TS1ATT (30, 15),  TS2ATT (30, 15)
      INTEGER MAX_SUBJS,  MAX_QUEST
      INTEGER LAST1,  LAST2
C
      TYPE *,  'STORING DATA IN FILES....STANDBY'
      TYPE *,  ' '
C
      CALL FILE_TIMES ('TACS1TIM.DAT',  TS1TIM,  LOG_UNIT,
     1                 MAX_QUEST,  MAX_SUBJS,  LAST1 )
C
      CALL FILE_ATMPS ('TACS1ATT.DAT',  TS1ATT,  LOG_UNIT,
     1                 MAX_QUEST,  MAX_SUBJS,  LAST1 )
C
      CALL FILE_TIMES ('TACS2TIM.DAT',  TS2TIM,  LOG_UNIT,
     1                 MAX_QUEST,  MAX_SUBJS,  LAST2 )
C
      CALL FILE_ATMPS ('TACS2ATT.DAT',  TS2ATT,  LOG_UNIT,
     1                 MAX_QUEST,  MAX_SUBJS,  LAST2 )
C
C
      RETURN
      END
```

```
C
C
C
C      *** PURPOSE ***
C      THIS SUBROUTINE WRITES THE TIME DATA ARRAY CALLED BY
C      SUBROUTINE OUT_DATA TO THE APPROPRIATE DATA FILE, AND
C      SUMS THE PHASE II AND PHASE III TIMES BY SUBJECT.
C
       SUBROUTINE FILE_TIMES (FILENAME,TEMP,LU,IMAX,JMAX,PAR1 )
C
C      *** VARIABLE DEFINITIONS ***
C      FILENAME = DATA FILE NAME
C      TEMP     = DATA ARRAY
C      LU       = LOGICAL UNIT NUMBER
C      IMAX     = MAX NUMBER OF QUESTIONS
C      JMAX     = MAX NUMBER OF SUBJECTS
C      PAR1     = CURRENT SUBJECT NUMBER
C      I, J     = COUNTERS
C      TSUMII   = TIME SUM ARRAY FOR PHASE II
C      TSUMIII  = TIME SUM ARRAY FOR PHASE III
C      FRTIME   = FRIENDLY TIME SUM ARRAY FOR PHASE II
C      ENTIME   = ENEMY TIME SUM ARRAY FOR PHASE II
C
       REAL TEMP (30,15), TSUMII (15), TSUMIII (15)
       REAL FRTIME (15), ENTIME (15)
       INTEGER IMAX, JMAX, PAR1, I, J, LU
       CHARACTER*12 FILENAME
C
       DO J = 1, JMAX
          FRTIME(J) = 0.0
          ENTIME(J) = 0.0
          TSUMII(J) = 0.0
          TSUMIII(J) = 0.0
       END DO
C
       DO J = 1, JMAX
          DO I = 1, 25
             TSUMII(J) = TSUMII(J) + TEMP(I,J)
          END DO
          DO I = 26, 30
             TSUMIII(J) = TSUMIII(J) + TEMP(I,J)
          END DO
       END DO
C
       DO J = 1, JMAX
          FRTIME(J) = TEMP(1,J)+TEMP(2,J)+TEMP(3,J)+TEMP(6,J)
     1                +TEMP(7,J)+TEMP(10,J)+TEMP(12,J)
     2                +TEMP(17,J)+TEMP(18,J)+TEMP(19,J)
          ENTIME(J) = TSUMII(J)-FRTIME(J)
       END DO
C
       TYPE *, 'WRITING TO: ', FILENAME
C
       OPEN (UNIT=LU, FILE=FILENAME)
C
       WRITE (LU,5) FILENAME
     5 FORMAT (57X,A12)
C
       WRITE (LU, 10) PAR1
    10 FORMAT (1X,I4)
C
```

```
      WRITE (LU, 20) (I, (TEMP(I,J), J = 1,JMAX), I = 1,IMAX)
   20 FORMAT (1X,I4,2X,F6.2,2X,F6.2,2X,F6.2,2X,F6.2,2X,F6.2,2X,
     1F6.2,2X,F6.2,2X,F6.2,2X,F6.2,2X,F6.2,2X,F6.2,2X,F6.2,2X,
     2F6.2,2X,F6.2,2X,F6.2)
C
      WRITE (LU, 21) 'PHASE II FRIENDLY TIME'
   21 FORMAT (/,51X,A22,/)
C
      WRITE (LU, 22) (FRTIME(J), J = 1, JMAX)
   22 FORMAT (6X,F7.2,1X,F7.2,1X,F7.2,1X,F7.2,1X,F7.2,1X,
     1F7.2,1X,F7.2,1X,F7.2,1X,F7.2,1X,F7.2,1X,F7.2,1X,F7.2,1X,
     2F7.2,1X,F7.2,1X,F7.2)
C
      WRITE (LU, 23) 'PHASE II ENEMY TIME'
   23 FORMAT (/,52X,A19,/)
C
      WRITE (LU, 24) (ENTIME(J), J = 1, JMAX)
   24 FORMAT (6X,F7.2,1X,F7.2,1X,F7.2,1X,F7.2,1X,F7.2,1X,
     1F7.2,1X,F7.2,1X,F7.2,1X,F7.2,1X,F7.2,1X,F7.2,1X,F7.2,1X,
     2F7.2,1X,F7.2,1X,F7.2)
C
      WRITE (LU, 25) 'PHASE II TIME TOTALS'
   25 FORMAT (/,52X,A20,/)
C
      WRITE (LU, 30) (TSUMII(J), J = 1, JMAX)
   30 FORMAT (6X,F7.2,1X,F7.2,1X,F7.2,1X,F7.2,1X,F7.2,1X,
     1F7.2,1X,F7.2,1X,F7.2,1X,F7.2,1X,F7.2,1X,F7.2,1X,F7.2,1X,
     2F7.2,1X,F7.2,1X,F7.2)
C
      WRITE (LU, 35) 'PHASE III TIME TOTALS'
   35 FORMAT (/,52X,A21,/)
C
      WRITE (LU, 40) (TSUMIII(J), J = 1, JMAX)
   40 FORMAT (6X,F7.2,1X,F7.2,1X,F7.2,1X,F7.2,1X,F7.2,1X,
     1F7.2,1X,F7.2,1X,F7.2,1X,F7.2,1X,F7.2,1X,F7.2,1X,F7.2,1X,
     2F7.2,1X,F7.2,1X,F7.2)
C
      CLOSE(UNIT=LU)
C
      RETURN
      END
```

```
C
C
C
C      *** PURPOSE ***
C      THIS SUBROUTINE WRITES THE ATTEMPT-NUMBER DATA ARRAY CALLED
C      BY SUBROUTINE OUT_DATA TO THE APPROPRIATE DATA FILE AND
C      TOTALS THE NUMBER OF QUESTIONS CORRECTLY ANSWERED ON THE
C      SUBJECT'S FIRST TRY.
C
       SUBROUTINE FILE_ATMPS (FILENAME, TEMP, LU, IMAX, JMAX, PAR1)
C
C      *** VARIABLE DEFINITIONS ***
C      FILENAME = DATA FILE NAME
C      TEMP     = DATA ARRAY
C      LU       = LOGICAL UNIT NUMBER
C      IMAX     = MAX NUMBER OF QUESTIONS
C      JMAX     = MAX NUMBER OF SUBJECTS
C      PAR1     = CURRENT SUBJECT NUMBER
C      I, J     = COUNTERS
C      SCORE    = PHASE II NUMBER OF CORRECTLY ANSWERED QUESTIONS
C                 ON FIRST TRY BY SUBJECT
C      FRSCORE  = PHASE II FRIENDLY SCORE
C      ENSCORE  = PHASE II ENEMY SCORE
C
       INTEGER TEMP (30,15), LU, IMAX, JMAX, PAR1, SCORE (15)
       INTEGER FRSCORE (15), ENSCORE (15)
       CHARACTER*12 FILENAME
C
       DO J = 1, JMAX
          SCORE(J) = 0
          FRSCORE(J) = 0
          ENSCORE(J) = 0
       END DO
C
       DO J = 1, JMAX
          DO I = 1, 25
             IF (TEMP(I,J).EQ.1) THEN
                SCORE(J) = SCORE(J) + 1
                IF (I.EQ.1) THEN
                   FRSCORE(J)=FRSCORE(J)+1
                ELSE IF (I.EQ.2) THEN
                   FRSCORE(J)=FRSCORE(J)+1
                ELSE IF (I.EQ.3) THEN
                   FRSCORE(J)=FRSCORE(J)+1
                ELSE IF (I.EQ.6) THEN
                   FRSCORE(J)=FRSCORE(J)+1
                ELSE IF (I.EQ.7) THEN
                   FRSCORE(J)=FRSCORE(J)+1
                ELSE IF (I.EQ.10) THEN
                   FRSCORE(J)=FRSCORE(J)+1
                ELSE IF (I.EQ.12) THEN
                   FRSCORE(J)=FRSCORE(J)+1
                ELSE IF (I.EQ.17) THEN
                   FRSCORE(J)=FRSCORE(J)+1
                ELSE IF (I.EQ.18) THEN
                   FRSCORE(J)=FRSCORE(J)+1
                ELSE IF (I.EQ.19) THEN
                   FRSCORE(J)=FRSCORE(J)+1
                END IF
             END IF
          END DO
```

```
            ENSCORE(J) = SCORE(J)-FRSCORE(J)
         END DO
C
      OPEN (UNIT=LU,FILE=FILENAME)
C
      TYPE *, 'WRITING TO: ', FILENAME
C
      WRITE (LU,5) FILENAME
    5 FORMAT (41X,A12)
C
      WRITE (LU,10) PAR1
   10 FORMAT (1X,I4)
C
      WRITE (LU,20)  (I, (TEMP(I,J), J=1, JMAX), I = 1,IMAX)
   20 FORMAT (1X,I4,2X,I4,2X,I4,2X,I4,2X,I4,2X,I4,2X,I4,2X,
     1I4,2X,I4,2X,I4,2X,I4,2X,I4,2X,I4,2X,I4,2X,I4,2X,I4)
C
      WRITE (LU,21) 'PHASE II FRIENDLY SCORES'
   21 FORMAT (/,35X,A24,/)
C
      WRITE (LU,22)  (FRSCORE(J), J=1, JMAX)
   22 FORMAT (7X,I4,2X,I4,2X,I4,2X,I4,2X,I4,2X,I4,2X,
     1I4,2X,I4,2X,I4,2X,I4,2X,I4,2X,I4,2X,I4,2X,I4,2X,I4)
C
      WRITE (LU,23) 'PHASE II ENEMY SCORES'
   23 FORMAT (/,37X,A21,/)
C
      WRITE (LU,24)  (ENSCORE(J), J=1, JMAX)
   24 FORMAT (7X,I4,2X,I4,2X,I4,2X,I4,2X,I4,2X,I4,2X,
     1I4,2X,I4,2X,I4,2X,I4,2X,I4,2X,I4,2X,I4,2X,I4,2X,I4)
C
      WRITE (LU,25) 'PHASE II SCORES'
   25 FORMAT (/,40X,A15,/)
C
      WRITE (LU,30)  (SCORE(J), J=1, JMAX)
   30 FORMAT (7X,I4,2X,I4,2X,I4,2X,I4,2X,I4,2X,I4,2X,
     1I4,2X,I4,2X,I4,2X,I4,2X,I4,2X,I4,2X,I4,2X,I4,2X,I4)
C
      CLOSE(UNIT=LU)
C
      RETURN
      END
```

```
C
C
C
C     *** PURPOSE ***
C     THIS SUBROUTINE ACCEPTS A "YES" OR "NO" ANSWER FROM
C     THE KEYBOARD.
C
      SUBROUTINE READ_ANS (ANSWER)
C
      CHARACTER*1 ANSWER
C
      ACCEPT 10, ANSWER
   10 FORMAT (A1)
C
      DO WHILE (ANSWER.NE.'Y'.AND.ANSWER.NE.'N')
         TYPE *, 'INVALID RESPONSE....TRY AGAIN.'
         TYPE *, 'TYPE CHARACTER ( Y OR N )'
         ACCEPT 10, ANSWER
      END DO
C
      END
C
C
C
C     *** PURPOSE ***
C     THIS SUBROUTINE CLEARS THE SCREEN.
C
      SUBROUTINE CLR_SCRN
C
      INTEGER I
C
      DO I = 1, 30
         TYPE *, ' '
      END DO
      RETURN
      END
```

APPENDIX I
POST-EXPERIMENT QUESTIONNAIRE

Your candid responses to the following questions will aid us in evaluating the usefulness of enhanced tactical symbology.

1. Did you have any difficulty learning the enhanced symbol set?

Yes 0 No 22 Comment:

- Symbols were very simple and easy to understand
- Logical use of information
- Reliance on distinctive geometric symbols aided search
- The acronym "PAWPEC" was very helpful

2. Did Phase I adequately orient you to the tactical situation and familiarize you with the tasks required in Phases II and III?

Yes 22 No 0 Comment:

- No comments received

3. Were all the questions you were asked during the experiment realistic?

Yes 22 No 2 Comment:

- Concerned with the attack force ratio where friendly force attacked defending forces of near equal strength
- Phase III Attack - Desired option to discontinue attack without force advantage

4. Regarding the friendly unit enhanced symbology,

a. Was too much information presented?

Yes 0 No 22

b. Was not enough information presented?

Yes 2 No 20

c. Did you have trouble reading or understanding any of the displayed information?

Yes 10 No 12

d. Would you prefer to select the information you need rather than have it displayed all at once?

Yes 5 No 17

e. Would you rather tailor the information you want simultaneously displayed?

Yes 6 No 16

f. Comments:

- Situation graphic control measures overlayed information in a few cases
- Video disc map resolution made map background distorted in certain areas
- Allows commander to see big picture, not just two or three areas
- Display all information to prevent commander from losing track of available information
- Have the ability to hide information in order to focus on the map

5. Regarding the enemy unit enhanced symbology,

a. Was too much information presented?

Yes 0 No 22

b. Was not enough information presented?

Yes 2 No 20

c. Did you have trouble reading or understanding any of the displayed information?

Yes 5 No 17

d. Would you prefer to select the information you need rather than have it displayed all at once?

Yes 3 No 19

e. Would you rather tailor the information you want simultaneously displayed?

Yes 4 No 18

f. Comments:

- Provide ability to focus on specific area of battlefield and eliminate distracting information
- Add enemy unit strengths to symbology
- Display as much enemy information as possible

6. Did the enhanced tactical situation displays appear overly cluttered making it difficult for you to understand and/or extract any information?

Yes 4 No 17 Comment:

No:

- Greater amount of information displayed with as much obscureness of screen as conventional symbols which displayed no information
- Much easier to extract and understand information

Yes:

- Only sometimes, first impression seemed to be cluttered
- Resolution of video disc map was not always good

7. Please assess the relative advantages and disadvantages of the enhanced versus conventional symbology in aiding your understanding of the tactical situations presented.

Advantages:

- Status of unit's combat effectiveness at commander's finger tips
- Commander can remain current on friendly/enemy status changes
- All information available about a unit is displayed at once
- Items of information displayed in one place
- Information could be easily extracted and understood
- Commander can assess situation and make decisions faster
- Crucial information stands out
- Presents accurate picture of situation

Disadvantages:

- Ability to keep information current
- Possibility of clutter

8. Do you have any suggestions for improving our enhanced symbology?

- Move symbols to top of viewing area, out of zone of action
- Display "PAWPEC" letters, above/below bars
- Use bold letters to portray equipment status
- Suppress items until required on display
- Decrease the symbol size slightly

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